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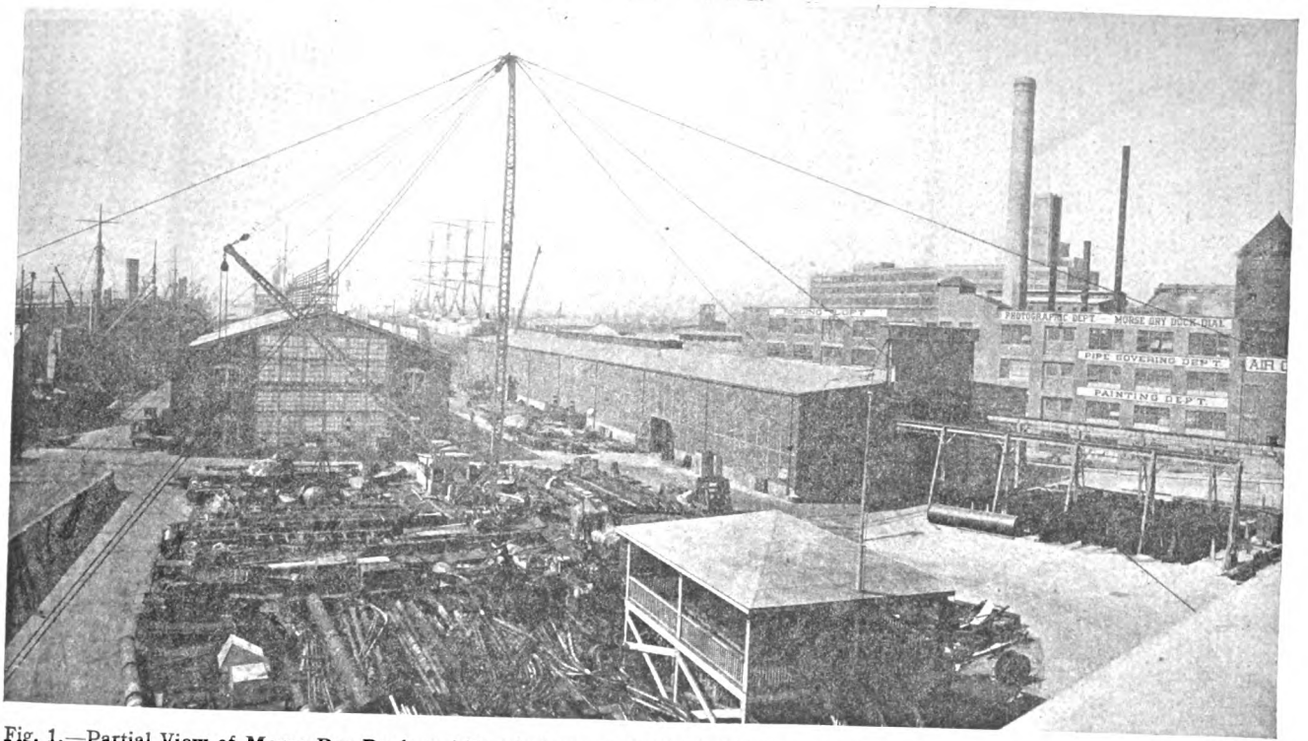

Fig. 1.—Partial View of Morse Dry Dock and Repair Company's Yards Showing the Arrangement of the Principal Shops, Docks, Plate Storage and Material Storage Spaces

The Morse Dry Dock and Repair Plant

Not least among the factors which have contributed to the success of the American shipping programme during the past two years has been the work of the repair yards along the coast. Of these, the Morse Dry Dock and Repair Company, of Brooklyn, N. Y., has rendered valuable service in keeping the army transports and supply ships in commission. Efficient organization methods, together with the support and co-operation of the men, have combined in making this plant an excellent one for turning out repairs rapidly.

THE foundations of the Morse Dry Dock and Repair Company's organization were laid about 1880, when E. P. Morse started a small ship-repair plant near the present site. For ten years the business progressed and the reputation of the company became established among shipowners and operators in the port of New York. In 1890 came the first setback, when the entire plant and equipment were destroyed by fire. Without great delay a new company was organized and soon regained the position held by the parent enterprise. During this period the company's first dry dock was built and put in operation.

Expansion was rapid and until 1903 no further trouble was experienced. At this time, however, a series of strikes closed the shops entirely and not until 1904 was the yard able to continue production on the open shop principle of labor, which has subsequently proved successful.

Policy of Expansion

Ten years ago a policy of building expansion was inaugurated, in order that equipment might keep pace with the business. Ships of all types and in all stages of repair were finding their way to the yard to be made seaworthy and the existing facilities of the plant were taxed to the utmost to accommodate them. Under the impetus of war needs the building programme was increased and went forward without interruption.

Temporary structures were put up to house the various departments during this expansion period, and as soon as a definite idea of the ultimate shop needs became

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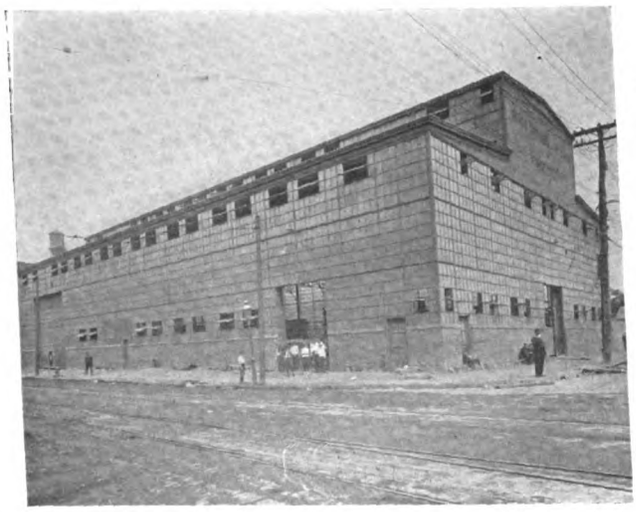

Fig. 2.—Exterior of Heavy Forge Shop

Fig. 3.—Woodworking Shop, Type of Concrete, Steel and Glass Building Constructed After the Fire of 1918

known permanent structures were commenced. In December, 1917, a disastrous fire destroyed nearly all the temporary structures, as well as part of the machine shop. This fire only served to hasten the completion of the new building plans, so that little time was actually lost in the production.

New Buildings

A modern concrete and glass building intended to accommodate the joiner and carpenter shops was practically finished at the time of the fire, so that these departments did not suffer any inconvenience. The existing machine shop was doubled in size and an addition made to the administration building; the warehouse capacity was doubled, a paint shop, pipe-covering shop, an electrical department and a power house, a copper and sheet metal shop, and a compressor plant were built. Adjacent to the carpenter shop a modern concrete building was put up to house a heavy forge plant.

As it exists today the main plant in Brooklyn covers 40 acres and employs about 6,000 men. An auxiliary yard, where sections for the Morse floating dry dock are built, is located not far from the main plant. By the summer of 1921, the third plant will be ready for production on Staten Island.

Organization

Facilities and equipment are at hand in the yard for carrying on practically any repair operation that may be required. As the dry docks are the base of operations for all the work in the plant they must be supplied by all the shops and equipment in the entire yard. An arrange-

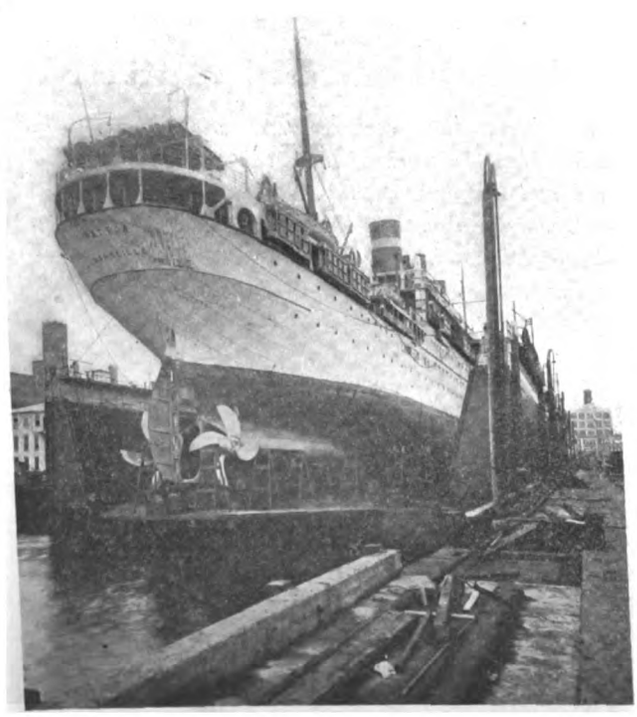

Fig.4.—S. S. Patria Lifted on Four Sections of 30,000-Ton Floating Dock in Record Time

Fig. 5.—The Yarmouth and Lake Fariston Lifted Simultaneously by Five Sections of 30,000-Ton Floating Dry Dock

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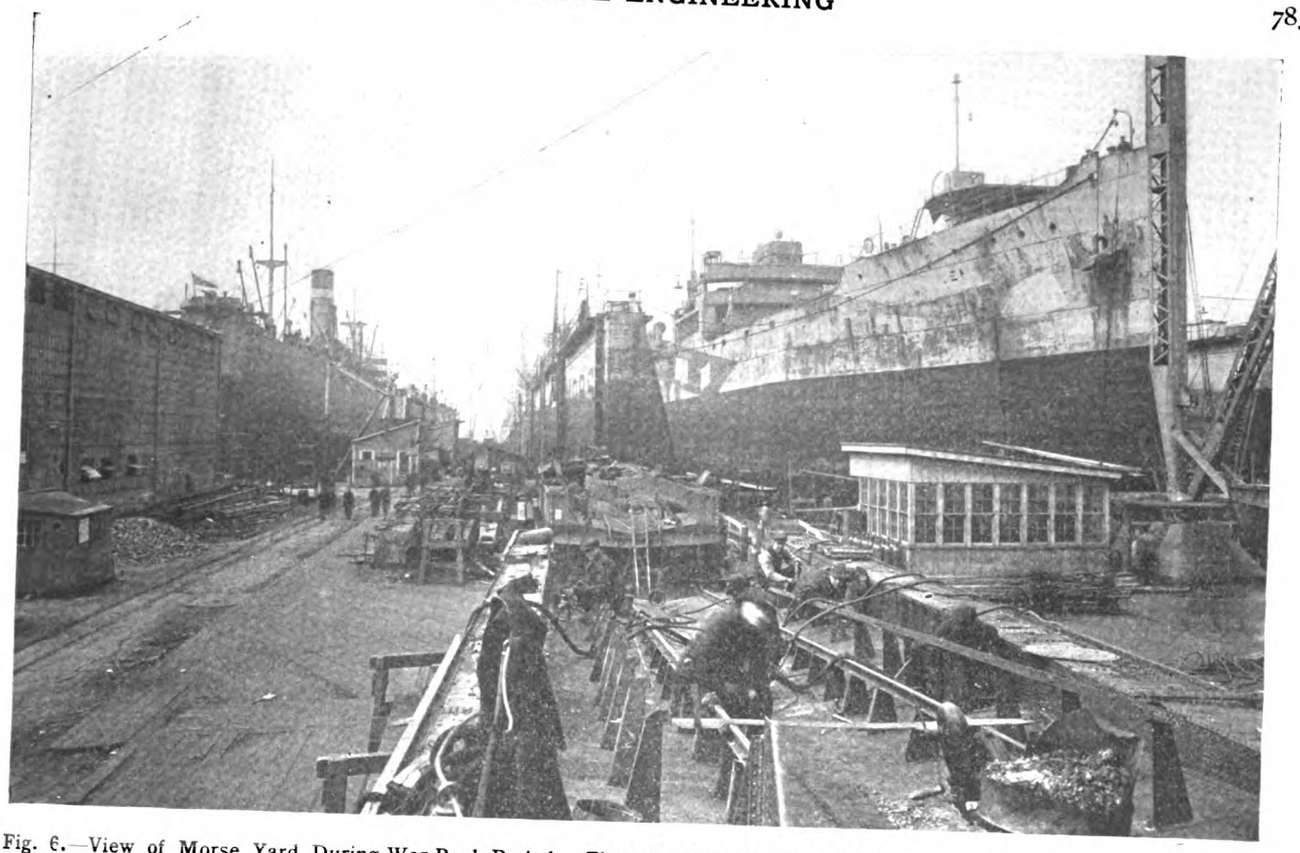

Fig. 6.—View of Morse Yard During War Rush Period. Three Sections of New Dock in Use at Right, Other Dry Dock at Left

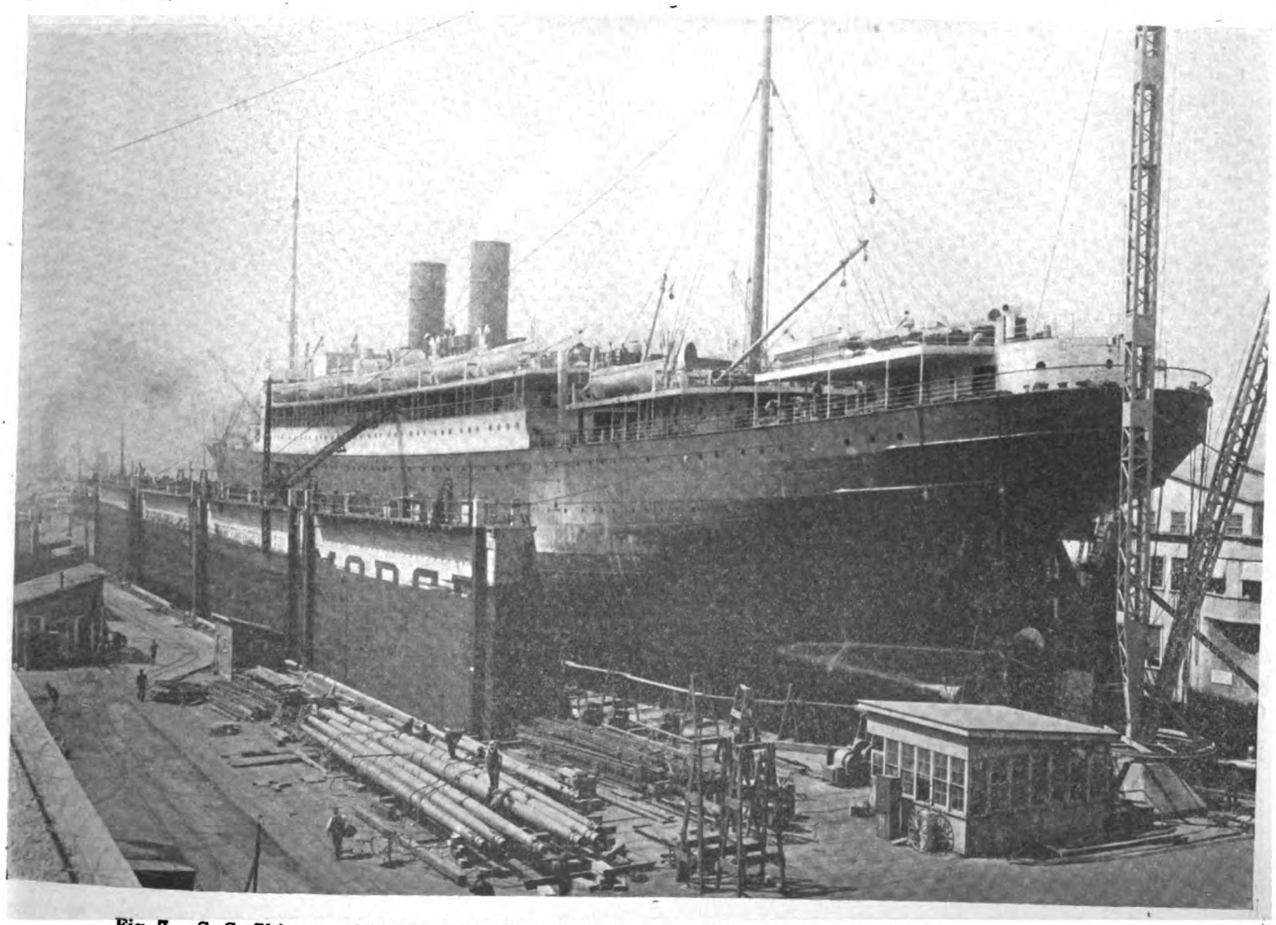

Fig. 7.—S. S. Chicago, of 11,127 Gross Tons, Raised on Four Sections of New Morse Dry Dock in 21 Minutes

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ment of departments will serve to indicate the general organization that is maintained for this purpose:

Floating Dry Docks, two:
- No. 1, 3 sections, lifting capacity 15,000 tons.
- No. 2, 6 sections, lifting capacity 30,000 tons.

Department of Administration:
- Offices of company.
- Office organization.
- Purchasing department.
- Publicity, advertising, photographic, printing.
- Solicitors (in ship repair plants a section is maintained for soliciting business from ships needing repairs as they enter port).

Technical Section
- Drafting (hull and engine).
- Estimators.
- Surveyors.
- Inspectors.
- Superintendents of departments.

Traffic Department:
- Motor trucks and repair shops for maintaining equipments.
- Electric utility tractors.

Salvage Department.

Store Rooms:
- Brass.
- Exterior shop storage, yard storage space for plates, boiler tubes and the like.

Receiving and Shipping Division.

Machine Shop.

Blacksmith Shop.

Boiler Shop.

Plate Shop.

Heavy Marine Forge Shop.

Electrical Shop.

Sheet Metal Works.

Nickel Plating Department.

Copper Shop.

Woodworking Building:
- Carpenter shop.
- Sawmill and lumber yard.
- Brazing.
- Joiner shop.
- Pattern shop.

Pipe Covering Department.

Plumbing Department.

Pipe Fitting Force.

Rigging Loft:
- Ship riggers.
- Crane riggers.
- Splicers.

Paint Department:
- Hull painters.
- Interior painters and decorators.

Floating Equipment:
- Ocean and habor tugs.
- Launches.
- Steam lighters.
- Welding barges.
- Dredges and scows.
- Pile drivers.

Burning and Welding Division:
- Electrical welding equipment.
- Oxy-acetylene welding and cutting.
- Acetylene compressing plant.

Ship Repair Division.

Hull Department:
- Riveting gangs, (riveters, holders-on, passers and heaters).
- Ship fitters.
- Chippers and calkers.
- Drillers and reamers.
- Airmen.
- Bolters-up.

Outside Machinists:
- Work on the ships.

Inside Machinists:
- Shop work, lathes, drills, etc.

Auxiliary Yard:
- Dry dock construction, ways and equipment.

Dry Docks

One reason for the success of the Morse Company has been the dry dock equipment, which on recent completion of the sixth section of dock No. 2 became the largest sectional floating dry dock in the world. It will accommodate a ship 750 feet long and of 30,000 tons deadweight.

Each of the six sections of the dock is 100 feet by 300 feet, with a lifting capacity of 5,000 tons, and of a special design produced by the Morse Company from its past experience in dock construction and operation. Over a million square feet of timber and 210 tons of bolts were used in the construction of each section.

The usual centrifugal pump equipment is located low down in each pontoon, connected by pipe lines to the watertight compartments on each side of the section. Gate valves operate in the suction pipes from the tops of the towers. Flooding pipes are also operated by gate valves controlled from the tower tops. Dock trimming is accurately maintained by the careful manipulation of these valves. Capstans and motors are mounted on the towers for actuating the pumps and handling the ships while in dock.

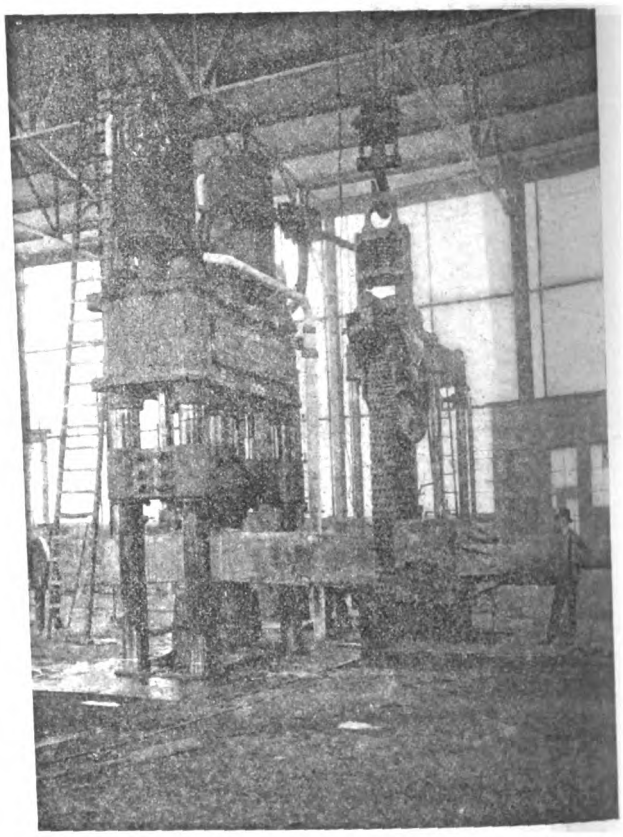

Fig. 8.—Hydraulic Press and Work Rotator in Action in Heavy Forge Shop

The sixth section, which was built in 64 working days, was launched September 26, and when put in operation early in November brought the dock up to its designed capacity of 30,000 tons.

Docking

In December, 1918, dock No. 2 became a productive factor in the yard, for the three sections then in commission were able to lift ships up to 15,000 tons net and 475 feet long. The *Black Arrow*, a Shipping Board vessel, was the first ship to be raised from the water in this dock. The speed of lift in this case was a foot a minute.

With the addition of later sections, the dock capacity has been increased. The French liner *Chicago*, 508 feet long, 57 feet 8 inches beam, 11,127 tons' deadweight, was lifted in 21 minutes. The French liner *Patria*, 485 feet 5 inches long, 56 feet beam, and of 12,000 tons, was docked for the first time on this side of the Atlantic in this dock. On November 8, when but two sections of dock No. 2 were in use, the steamships *Yarmouth* and

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Fig. 9.—Work being Carried on in the Blacksmith Shop

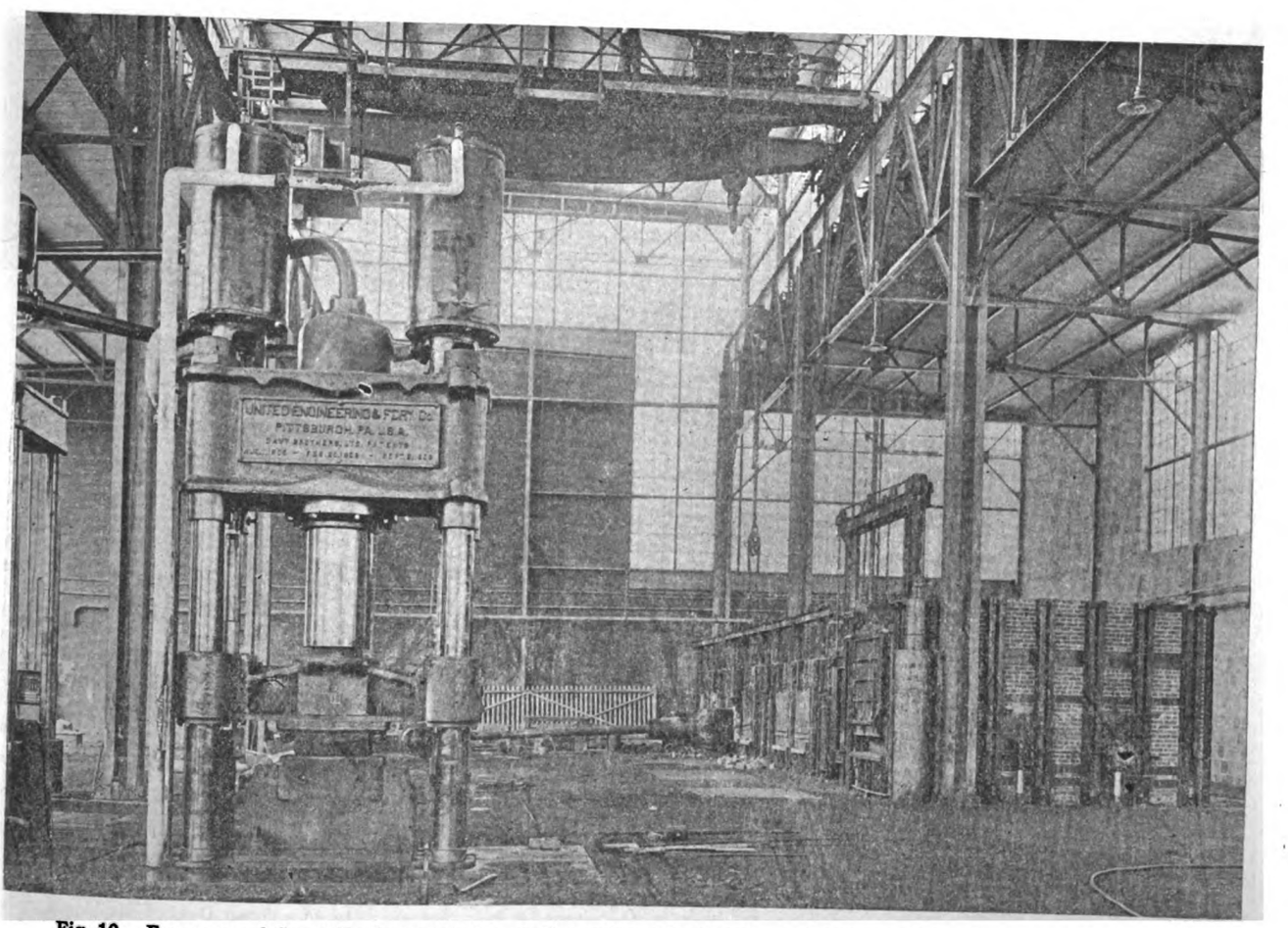

Fig. 10.—Furnace and Crane Equipment in Heavy Forge Shop Used to Supply Billets to Hydraulic Press and Hammers

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Fig. 11.—All Patterns Required by the Morse Company Are Made Up in This Shop and Supplied to Outside Firms for Pouring the Necessary Castings

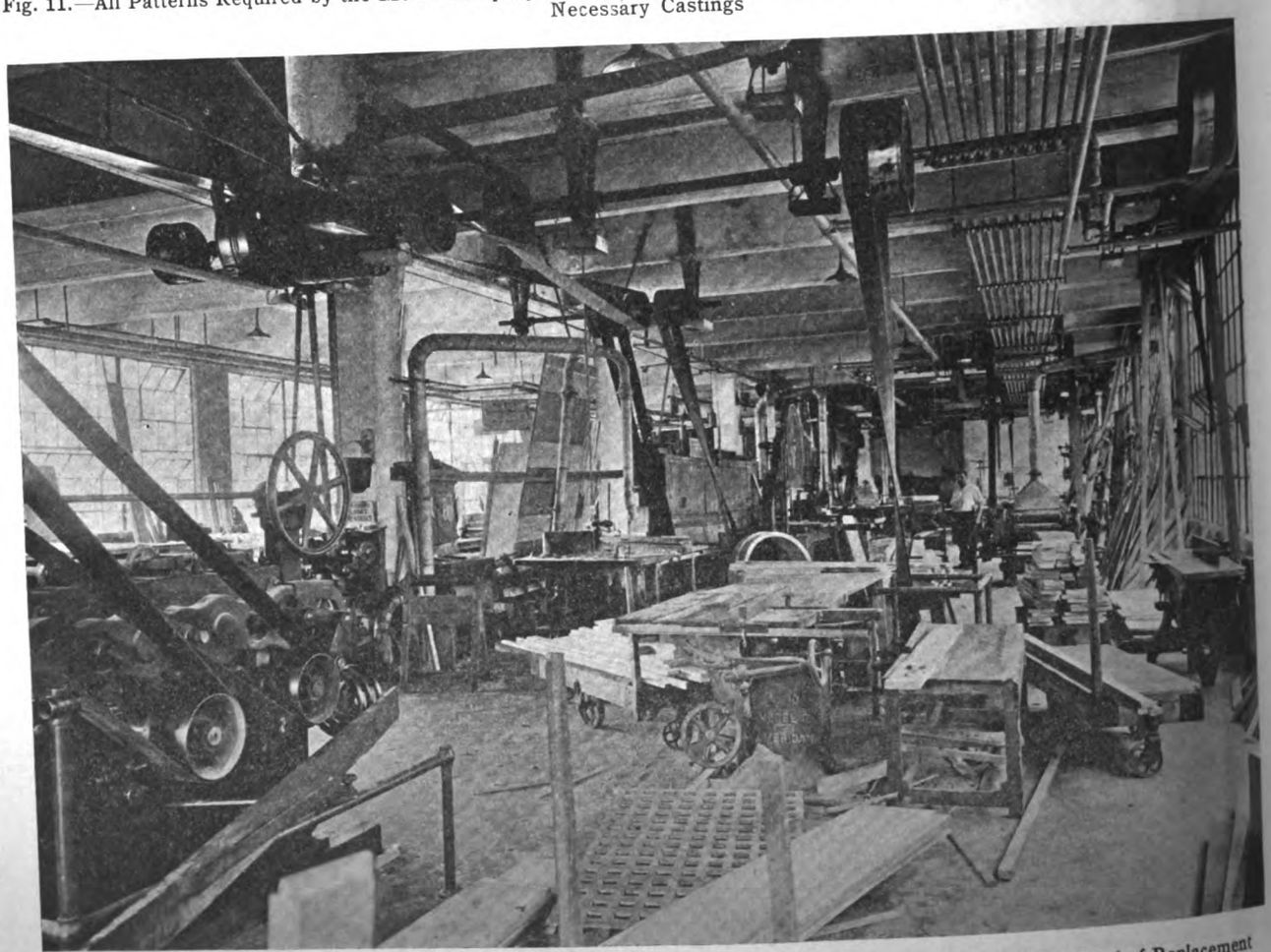

Fig. 12.—The Joiner Shop of a Ship Repair Plant is Particularly Important for It Is Necessary to do a Great Deal of Replacement Work and the Shop Equipment Must be Adequate to the Needs, as in this Case

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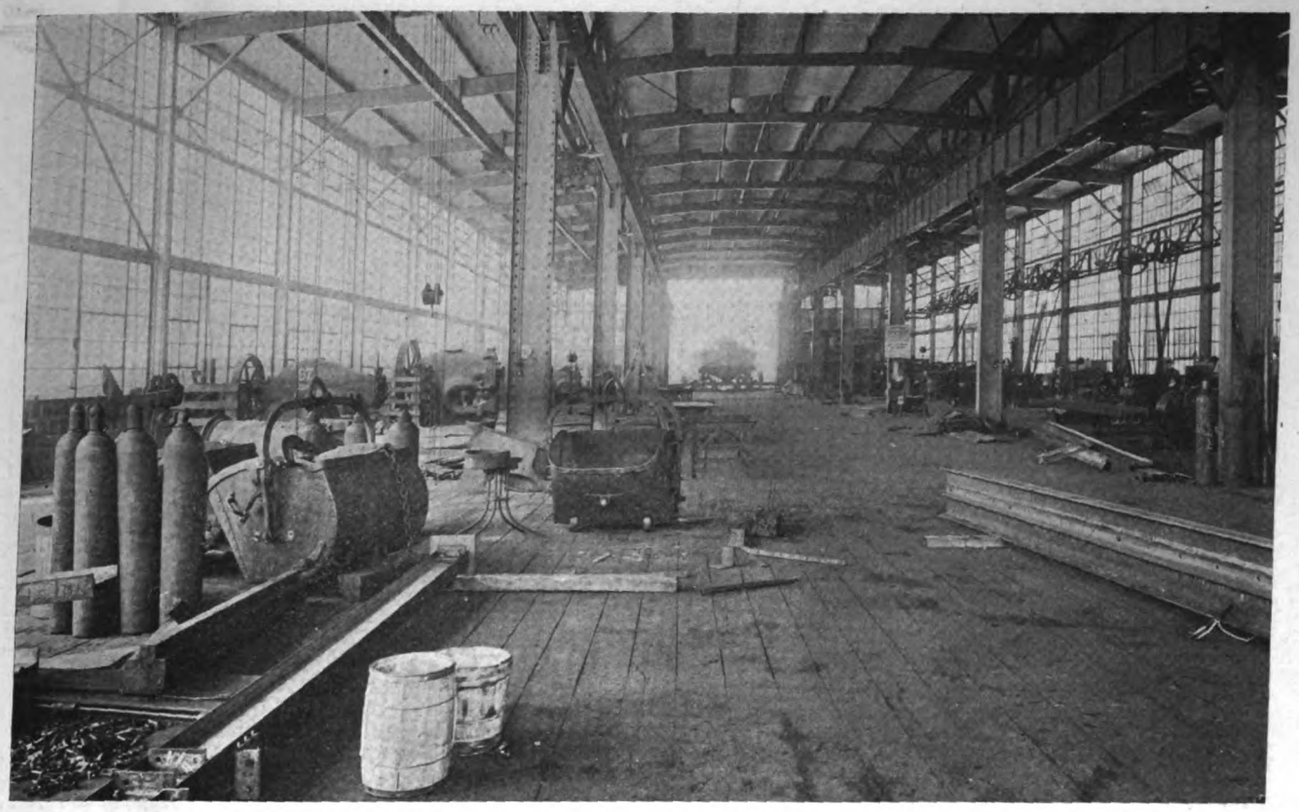

Fig. 13.—General View of Plate Shop in Which a Clear Space Has Been Maintained Through the Center for Facilitating the Construction of Superstructures Complete

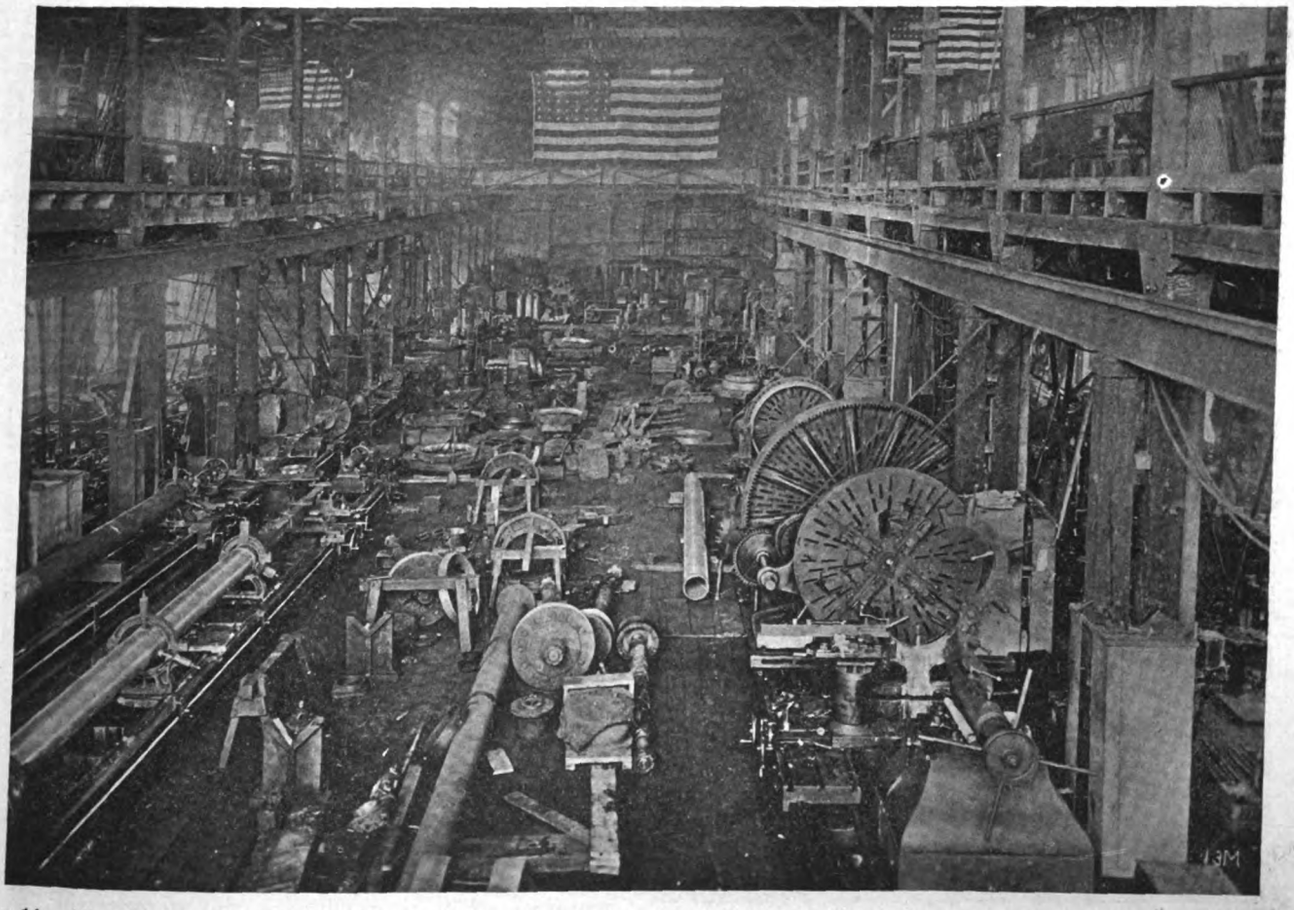

Fig. 14.—All of the Shop Work Required in the Construction of Engines or in Their Repair as Well as a Vast Amount of Other Machine Work Can be Carried on Without Aid From Other Plants

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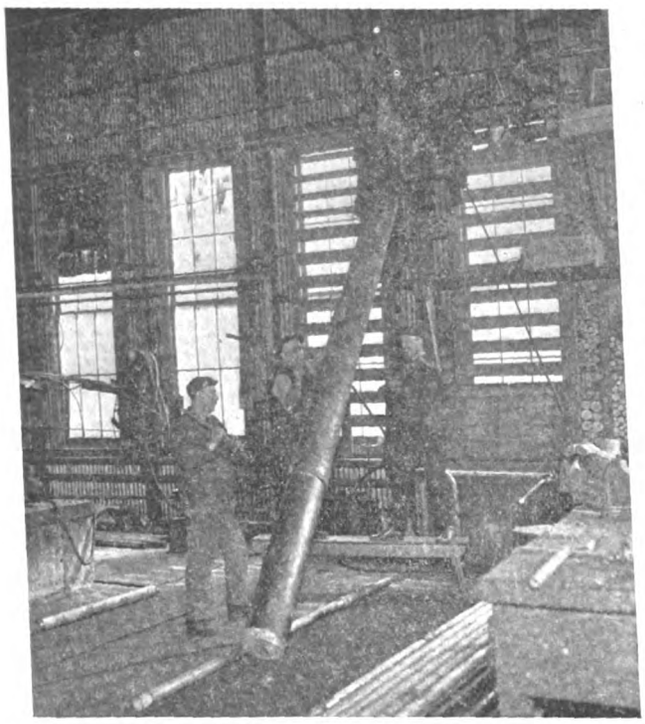

Fig. 15.—Filling a Large Pipe with Sand Before Bending

Lake Fariston were both docked, work being done to the *Lake Fariston* while the *Yarmouth* was being lifted.

TUGBOAT FLEET

The floating equipment includes lighters, dredges, scows, harbor and seagoing tugs and launches. The policy of maintaining company-owned tugboats has tended towards economical and rapid service by making the yard independent of the commercial tug. Delays in handling ships in and out of the docks have thus been eliminated. The tugboat fleet consists of three seagoing tugs, the largest and most recently constructed of which is the *E. P. Morse,* and three harbor tugs. The *E. P. Morse* is the only tug in the port of New York fitted for ice breaking. She has accommodations for a crew of 18 men. The second largest seagoing tug, the *Anson N. Bangs,* has the following details of construction:

Length overall, 101 feet.
Beam, molded, 23 feet.

Fig. 16.—The Same Pipe in Process of Bending

Depth, molded, 22 feet 2 inches.
Draft, forward, 9 feet 6 inches.
Draft, aft, 13 feet.
Gross tonnage, 178 tons.
Net tonnage, 68 tons.
Speed, 12 knots.
Cruising radius, 960 miles at 10 knots.
Compound engines, 22 inches by 40 inches by 28-inch stroke.
One Scotch boiler, 15 feet diameter, 11 feet 9 inches long, with three furnaces.
One surface condenser.
Generator, 1 kilowatt.

The third seagoing tug is somewhat smaller than these two, but has made good performance records in towing. Two of the tugs recently made the run from Norfolk, Va., to New York, towing a 4,218-ton vessel, in 50 hours. At another time the Argentine transport *Pampa,* the rudder of which had been carried away in a storm, was towed from Newport News, Va., in 53 hours. The *Ansaldo III,* an Italian tank steamer, adrift and short of fuel, was towed into port stern first without difficulty in about three hours.

Five barges and lighters with three soliciting launches make up the remainder of the fleet. The barges are equipped as floating machine shops; the largest lighter has a 20-ton derrick, a Worthington air compressor of 250 cubic feet per minute capacity, and a deck loading capacity of 200 tons, but is without welding apparatus. The others vary but slightly in these details, but in each case have welding equipment. The welding outfits are of various types and will be described later, but combined there are two 2-men and three 3-men equipments. The total compressor capacity amounts to 1,160 cubic feet of air per minute.

YARD EQUIPMENT

Practically every detail of repair or construction work can be done in the yard without aid from outside plants. In the process of fabricating a structure, either new or one that is being repaired, the movement of the parts is from the head of the yards down to the docks, and return movements of material have to a great extent been eliminated.

WOODWORKING SHOPS

Just outside the yard proper are the woodworking shops, containing the carpenter, joiner and pattern-making departments. The equipment in all these departments is quite complete and includes several special devices which have been developed for quantity production in the woodworking trades. Besides the regular band, circular and swing saws, planers and lathes that are to be found in up-to-date woodworking shops, the equipment includes: A four-sided planer, two traveling dado heads, a 5-foot sanding machine, several hollow-ground mortising machines, and a number of others adapted for particular uses in the pattern and joiner shops.

HEAVY FORGE PLANT

The heavy forge shop is equipped to handle all kinds of iron and steel forgings for marine and industrial purposes, but specializes in tail shafts, crank shafts, crank pins, connecting rods, eccentrics, stern frames, rudder stocks and the like. Forgings up to 50,000 pounds may be prepared to meet the needs of the yard, as well as those of other shipyards, machine tool manufacturers, machine shops and cement crusher mills.

The equipment includes: a 40,000-gallon fuel oil storage tank, two electric traveling cranes of 30 and 40 tons capacity, respectively; a 30-ton stiff-leg crane, a 25-ton derrick, a Claridge fan blower driven by a 50-horsepower motor, a steam air compressor and storage tank, two fuel oil pumps of 1 horsepower each. Hoisting and han-

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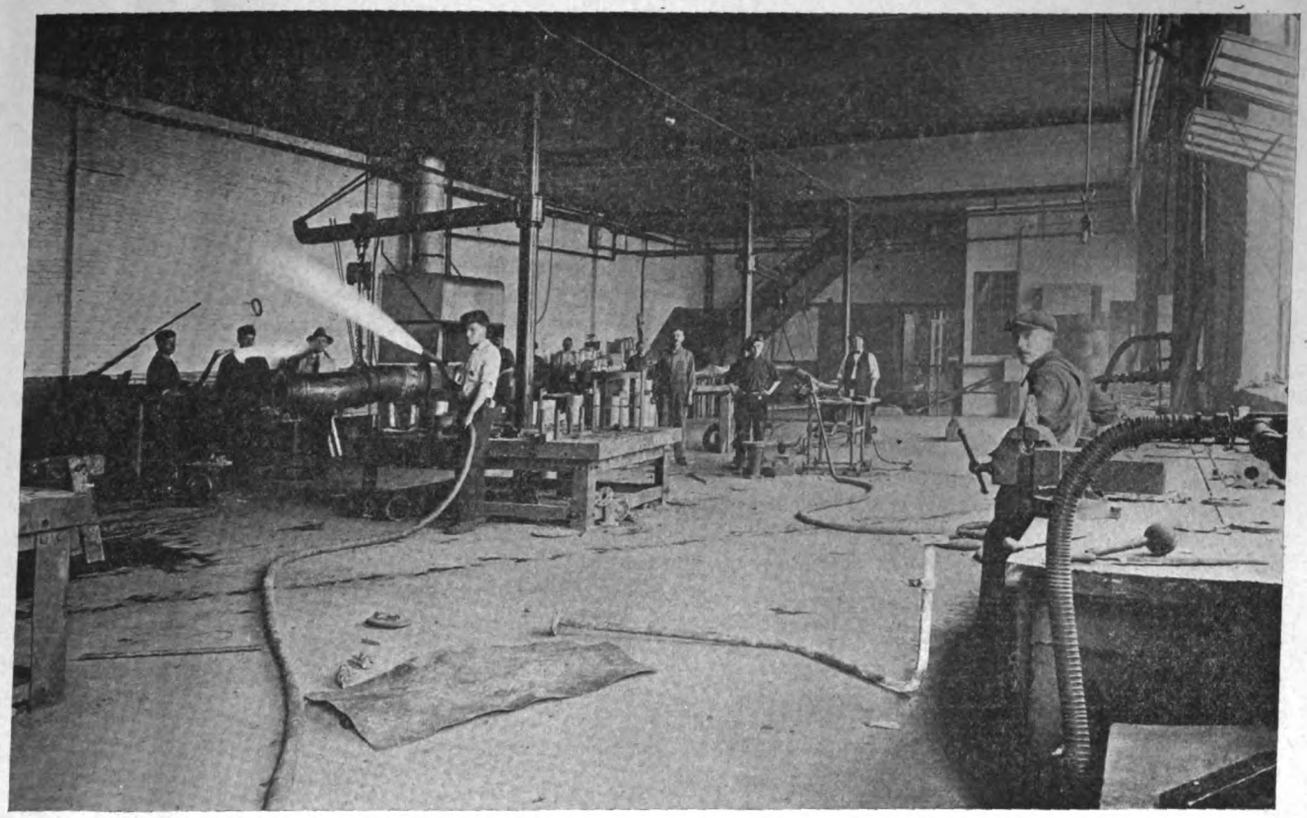

Fig. 17.—A Complete Copper Working Shop Is Maintained in the Yard

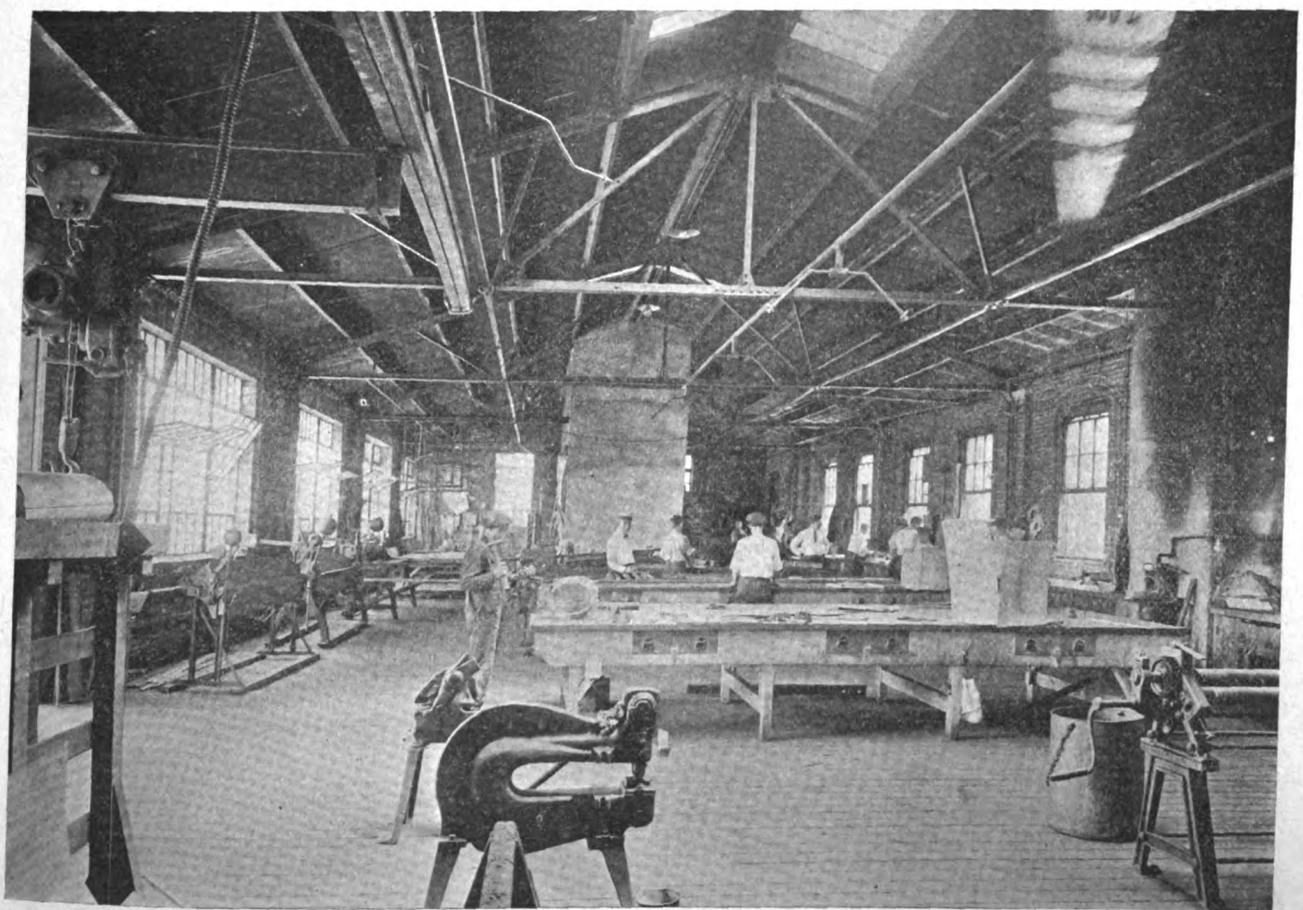

Fig. 18.—Sheet Metal Work Necessary in Building Tanks, Cowls and the Like is Produced in the Shop Fitted for this Work

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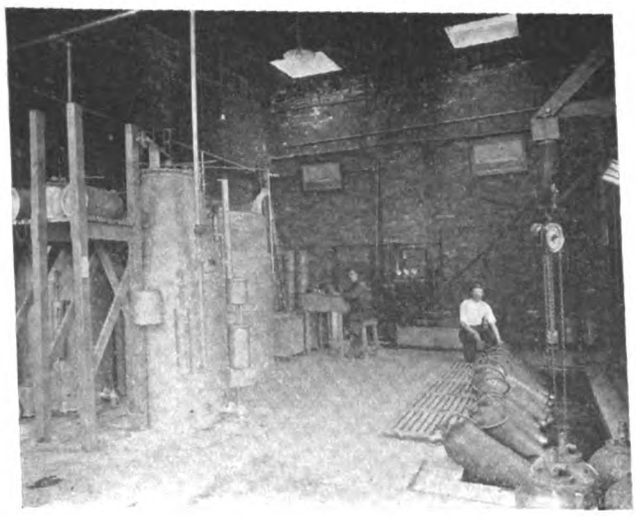

Fig. 19.—Acetylene Generating Plant Built During the War in Order that a Constant Supply of Gas Might be Available in the Yard

dling equipment is supplemented by a 10-ton auxiliary hoist. Two 25-ton rotators may also be used for hoisting work, but are particularly adapted to rotate material that is being worked under the hammers. A 1,200-ton steam hydraulic press weighing 50 tons is capable of delivering a maximum pressure of 1,500 tons. The hammers include a 4,000-pound steam trip of the double frame type capable of handling work up to 5 tons, and several smaller machines. There are 10 furnaces, each having 26 oil burners used to keep metal supplied to the hammers and presses, as well as for annealing and heat treating such forgings as require these processes. Ingots up to 25 tons may be heated in the furnaces.

Welding Equipment

During the summer and winter of 1918, the acetylene supply in the yards for welding and cutting operations was anything but certain. As a result arrangements were made with the Davis Bournonville Company, Jersey City, N. J., to erect a special generator plant in the rear of the heavy forge building for supplying the needs of the shops. The little generating plant that resulted is very complete and is able to produce 13,000 cubic feet of gas per week. Generating and compressing processes are carried on in:

Two generators having a carbide capacity of 3,000 pounds each.
One gasometer, 100 cubic feet capacity.
One Frankoline purifier.
One compartment filled with limestone.
Two drier sections.
One compressor, having a capacity of 6 cubic feet per minute at a pressure of 250 pounds per square inch, operating at 72 revolutions per minute.
One five-horsepower Crocker Wheeler motor, 3-phase, 220 volts, 132 amperes, 750 revolutions per minute.

This system is capable of charging 12 tanks of three different sizes at a time. Steam heat is utilized to keep the temperature of the gas constant in winter during the charging process. About eight tons of carbide is stored in the supply vault.

Danger from explosions has been reduced to a minimum by fitting special ventilators in the roof to carry off any gas that might accumulate in the generating chamber. All electrical equipment is non-sparking, which also tends to increase the safety.

Acetylene welding equipment in the yard is divided between the shops and the docks. Five outfits are kept busy in the blacksmith shop, welding angle irons, frames, deck house fittings and the like. Five more work on castings all the time, while about a dozen are utilized for general work on the ships and eight or ten by the chippers and calkers.

Electrical outfits used to advantage on the barges previously mentioned include one Wilson 2-man unit on the *John Hallock*. The lighter *Panuco* is similarly equipped, but with a Lincoln type instead of the Wilson. The *Captain Roche* and *Captain Kirby* each have one 3-man Westinghouse set, while the latter has one 2-man Wilson in addition. All electrical welding apparatus in the yard operates at 300 amperes and 175 volts. Special units for use in various parts of the yard include four small outfits and two double Lincoln sets.

On the *Von Steuben*, a converted ex-German ship, 32 sheets in the main boilers were welded by one gang in 60 days, this time including the acceptance tests. A base for the turning gear on the *General Gorgas* was lined up and welded in 24 hours. Three rudder chocks were repaired on the battleship *Texas* in 5½ working days, by means of the oxy-acetylene torch. This repair saved the necessity of installing a new stern frame. Another special job on the tail shaft of the *Arizona* is being completed at this time. The shaft in question was forged one-inch smaller in diameter than required. Additional metal has been welded onto the shaft by means of the electric arc, so that the diameter after machining will be as originally designed.

Plate Shop

As in the case of the other shops in the yard, the plate shop is intended for the fabrication of repair parts rather than complete ship production. For this reason the machine equipment is of a slightly different character and

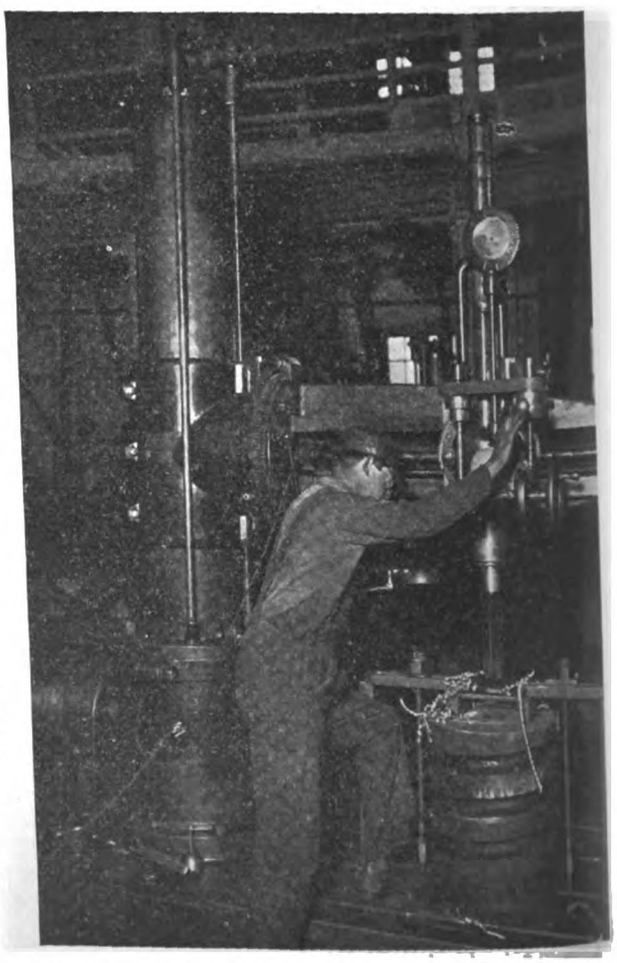

Fig. 20.—Machine Developed in the Morse Plant for Boring Square Holes

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arranged in a different manner than is the practice in shipbuilding plate shops. The machine layout is such that the complete assembling of deck houses and superstructures may be carried on efficiently, as this sort of work is done to a great extent to eliminate the delays attending their fitting on the ship. The ordinary production required is readily handled in this shop.

BLACKSMITH AND BOILER SHOPS

The boiler making department and the blacksmith shop are housed in a glass and steel building, 152 feet by 81 feet, and are equipped to handle any work that may be required of them.

Five 12-inch Potter McDougall steam hammers and one 9-inch steam hammer of the same make constitute the main equipment of the blacksmith shop. A pair of alligator shears made by the Canton Foundry and Machine Company, driven by a 15-horsepower General Electric motor, accommodates round and square metal up to 3½ inches. Forced draft for 30 fires in the shop is supplied by a Buffalo Cupola and Forge blower, driven by a 10-horsepower motor, and an auxiliary blower of the Garden City Fan Company, driven by a 5-horsepower Watson motor.

On the U. S. S. *Von Steuben,* which was converted into a troopship in the Morse yards, twenty-eight back connection tube heads were cut out, renewed and installed, new fireroom flooring was fitted and the boilers generally overhauled. During most of the period required for this repair (about 3½ months) seventy men were at work in the day time and about fifty in the night shift. This repair job was probably the most extensive of any handled by the boiler department during the war.

One of the most rapid repair jobs done by the boiler crew was on the supply boat *Orian.* Fifteen men of the boiler department working on day and night shifts retubed one double-ended boiler, did all of the calking necessary and put in new fireroom foundations and flooring in five days.

MACHINE SHOP

When the fire of 1917 gutted the existing machine shop, a structure of double the previous size was built. This building, of steel and glass construction, is 210 feet 2 inches by 81 feet, and contains equipment for handling both regular and special machine requirements.

Power for the yard is supplied by the Edison Company through 6,600-volt feeders to three sub-stations, where the current is converted to 440, 220 and 110 volts, 3 phase, 25 cycles, and distributed to all parts of the yard.

COMPRESSOR PLANT

The compressor plant is equipped with two electrically driven Ingersoll-Rand compressors, each delivering 3,750 cubic feet of air per minute at 100 pounds per square inch pressure. They are driven by two 600-horsepower Westinghouse synchronous motors operating at 6,300 volts, each equipped with a Westinghouse starting compensator and an oil circuit breaker. Low pressure compressor cylinders have a 32-inch bore and 24-inch stroke; high-pressure cylinders 20¼-inch bore and 24-inch stroke. Two 10-kilowatt, 125-volt, 80-ampere, 950-revolution per minute, belt-driven exciters, two Westinghouse transformers and a Gould well-pump for cooling purposes, having a capacity of 75 gallons per minute and driven by a 10-horsepower Westinghouse motor, complete the compressor room equipment. An auxiliary compressor of the Ingersoll-Rand steam-driven type, delivering 1,000 cubic feet of air per minute, is located in the boiler house, and an additional electric compressor, also delivering 1,000 cubic feet per minute, is in the process of installation.

The boiler shop is equipped with four boilers, two of the upright fire-tube high-pressure type, generating steam at 150 pounds per square inch, and two McNall watertube boilers generating steam at 100 pounds pressure. The heavy forge plant is supplied by an independent boiler department equipped with two 300-horsepower McNall watertube boilers.

SALVAGE DEPARTMENT

Until recently shipyards have not considered the salvage department as a necessity in their operations. During the war, however, its great value was recognized and practically every yard of size had such a section. Particularly in a repair plant is there a vast amount of usable material which is ordinarily discarded while a ship is being refitted. Besides the rivets, plates, beams and steel sections dismantled, there are oftentimes engine parts, boilers, galley equipment, stewards' supplies and vast quantities of other material that have to be replaced or eliminated before the ship is considered to be in condition for service.

In the Morse yard, the salvage work is carried on by a crew of about twenty men, aided by motor trucks and electric tractors. Each department and shop has a bin into which all waste material is thrown to be collected and inspected later. In this way quantities of bolts, rivets, angle irons, ship's ladders and the like are put into shape for use again, while all manner of supplies and junk are sold to outside firms.

SPECIAL REPAIR JOBS

Much of the early war work was in converting German ships into troopships, all of which had to be done very quickly, so that the troop movements would not be delayed or interrupted. The *Kaiserin Augusta Victoria* and the *Mobile* were turned out at the Morse plant and the Hoboken division in eleven and twelve days, respectively, ready for service. The old army transport *Henderson* had the sole plates and engine foundations in general repaired in 39 days. To facilitate this work the engine had to be lifted four feet from the base and braced in this position until the new foundations were installed. On another occasion the *Imperator* was completely painted in 12 days.

One of the best records accomplished in the Morse plant was the refitting of the *George Washington* in 76 hours. Just before her voyage with the President's party, 49 staterooms were refitted and redecorated, destroyed furniture replaced and old furniture rebuilt. Besides work on the staterooms it was necessary to equip sixteen bathrooms. Hot water piping had to be installed, as well as the existing salt water lines eliminated. A conference hall was built, two smoking rooms aft were entirely remodeled, a ladies' lounge fitted and all the main corridors redecorated.

In keeping with the United States Shipping Board's policy of expansion, the U. S. S. *Huron,* formerly the *Frederick der Grosse* of German naval command, has come to the Morse yards to be fitted as the finest U. S. government passenger and merchantman. The *Huron* contract involves a large sum of money and a great volume of work and is considered by shipping men in general to be the largest ship repair job ever undertaken in America.

REFITTING THE HURON

Prominent among the operations the *Huron* will undergo is the installation of a fuel oil burning system of 24 furnace fronts, complete with burners, to operate under natural draft, and three oil heaters any two of which are to be capable of operating the entire plant. Another installation job of big proportions is that of a

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Sperry gyro stabilizer with a foundation for it that will take a maximum thrust of 470,000 pounds.

There will be provided also suitable seatings and fastenings for the following auxiliary apparatus to be located in No. 6 hold adjacent to the gyroscope: One rotary converter, a switchboard, two steam oil pumps, one strainer, one oil tank, one set of resistance grids, one vacuum pump, one control gyro, one cooler, and one steam-driven electric generator. The necessary steam and exhaust piping to pumps and generator, and salt water supply, and a drain to cooler, will also be furnished.

A gymnasium, located abaft the engine room hatch, is to be constructed of wood and will have windows of opaque glass with Louvre shutters. A new house for the wireless room will be erected, as will a new house to contain the first and second-class hospitals. The entire after end of the deckhouse is to be completely rearranged, the space in the center to be used as a library and reading room. These will be finished in hardwood wainscoting and pine paneling.

The second-class smoking room is to be fitted with paneled oak settees with spring seats and upholstered backs and the deck covering will be rubber or cork tile. A printing shop will be erected on the port side. The passenger rooms in general are to be fitted with a view to the utmost cleanliness, airiness and sanitation. Forty new outside hardwood doors to staterooms are to be fitted in a steel house, and a fire indicating and extinguishing system, to be used in connection with a smothering system, is to be installed.

While the *Huron* is considerably smaller than the *Leviathan,* it is much larger than the ordinary run of Shipping Board vessels. It is 545 feet long and of 10,800 gross tons. Interned in New York harbor at the outbreak of the European war, the *Huron* was taken over by the United States upon our entry into the conflict. Like other German ships, she was more or less damaged by her German commanders and crew, but American ingenuity and initiative soon got her into commission and she gave excellent service. Her usual runs as a troopship were between Norfolk and St. Nazaire, France. She carried on each trip (more than a dozen in number, with and without convoy) 4,500 officers and soldiers beside a ship's crew of 500.

Her career as a troopship was not without event. One night when about 200 miles off St. Nazaire she struck something, presumably a German submarine. No damage was sustained by the *Huron,* but members of her crew felt that there was one less enemy submarine at the close of the incident, for when a ship the size of the *Huron,* heavily laden and traveling at 15 knots, hits anything, there is small chance for the rammed craft to survive.

EMPLOYEES' ASSOCIATION

Practically all of the employees of the Morse Company belong to an association which in addition to its promotion of social intercourse has the fundamental object of looking after the welfare of the men while at their work in the shops. The association was organized about three years ago and is now perhaps as far advanced as any similar representative body in the country. The officers of the association are nominated and elected each year by popular ballot and at election time enthusiastic campaigns are carried on.

A sanitation committee, an accident prevention committee, a fire prevention committee and various other committees look after the welfare of the men. In addition to a president, vice-president, secretary and treasurer, there is a board of directors represented by one man from each department in the yard and also a conference board represented by two men from each department. In case any question arises concerning wages, hours of labor and other matters which require adjustment, the very simple expedient of placing the matter before the conference board and the company has proved successful. The company has an industrial director, who upon receiving any complaint from the men immediately seeks to straighten the matter out. If he is unsuccessful, the complaint is taken before a joint meeting of the conference members, representing three members for the men and three representing the company. In every case thus far the conference board has worked successfully.

In connection with the association the company publishes a monthly magazine, which has the distinction of being the first shipyard magazine in the country. A complete printing and photographic division is carried on in the plant so that even in this respect the yard is independent of outside help.

Increasing Stoke-Hole Efficiency

BY A. POHLMAN

AT this particular time every thinking marine engineer can plainly see the writing on the wall. He realizes as his brother engineer in the stationary field that the old rule of thumb methods of operation are no longer applicable to modern power plant operation either ashore or afloat. Indications today point to the marine engineer as one of the factors by which the powers that be will decide whether or not the stars and stripes will maintain their rightful place on the seas.

It is an established fact that the major cost of power is not labor, maintenance, supplies, interest, etc., but fuel. It was a common occurrance not long ago to find on investigation that fuel constituted eighty percent of the entire cost of operating. It is therefore apparent that the place to start to effect a reduction is the coal pile, not the pay roll.

An engineer would not attempt to guess at engine performances; he would use his indicator. Why not apply the same method to the boiler plant? Indicate your boiler furnace. It's simple, and one then knows absolutely—no guesswork. A furnace is nothing but a large carburetor. Get the right mixture and economy follows as a natural result.

The orsat or flue-gas analyzer is the indicator for furnace use. A half hour of practice combined with a little horse-sense will enable any engineer to use this instrument well enough to obtain very satisfactory results.

A sample of flue gas is taken at the point where the gases leave the heating surface of the boiler. This sample is then analyzed by means of the analyzer and the contents of CO_2, O and CO, respectively, are noted.

At the same time the draft and the thickness of fire are also noted.

From the above factors a practical fixed thickness of firebed and speed of blower or damper opening for that particular fuel are determined. This applies to either solid or liquid fuel.

This article is not intended for those who are familiar with flue-gas analysis but for those who are not versed in the subject. Incidentally, the writer would say that it is not even necessary that the operator know what CO_2 or CO is. While every engineer should know the meaning of these various symbols and something of the theory of combustion, anyone who can read a thermometer scale can use a flue-gas analyzer successfully.

The practical use of the analyzer will be explained in a later article.

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Merchant Marine Hearings in Washington

Congress Still Taking Evidence—Favorable Report on Greene Bill the First Step Towards a Definite Marine Policy

By WALDON FAWCETT

BY means of public hearings in committee and through the medium of a voluminous correspondence, the Congress of the United States continues to acquire information on all phases of the subject of the American merchant marine. It became evident, however, early in the autumn that the legislation in encouragement of creation and maintenance of an American merchant marine and the fostering of an American shipbuilding industry, of which all this investigative work is the prelude, cannot materialize at the first special session of the 66th Congress. Authorization of a Governmental policy with respect to the merchant marine and allied activities waits upon the regular session of Congress that will convene in December. Meanwhile the hearings continue, and if any interest in the marine field remains unheard in this sounding of the sentiment of the industry, it will not be for lack of opportunity.

Although there lags somewhat the general legislation that will determine the attitude of the United States Government toward the merchant marine, it is worthy of note that Congress is making some progress in the direction of the legislation that will prescribe the nature and extent of Federal supervision and regulation of the railroads of the country after the rail lines have been returned to private management. It has come to be realized latterly that not only will the future of railroad operating policy have a broad if indirect influence, via export movements, upon the American merchant marine, but that there is, in the case of the coastwise lines, an intimate connection between the two classes of carriers. Accordingly, the outcome of the railroad legislation may, with advantage, be scrutinized for its effect upon coastwise shipping and shipbuilding.

While Congress continues, for the time being, in the attitude of listening to the evidence rather than attempting a verdict on the merchant marine issue, it is interesting to note the first appearance, from an authoritative source, of a bill designed to meet the present situation. Congressman Greene of Massachusetts introduced in October a bill, designated officially as H. R. 9823, which has as its object the repeal of certain existing legislation connected with the upbuilding of the American merchant marine and providing for the disposition, regulation and use of the property built or acquired by the United States under the emergency shipping fund provisions. This bill is worthy of more than passing notice owing to the circumstance that its author is chairman of the committee on the merchant marine and fisheries of the House of Representatives. To be sure, the measure has not been "reported out" or recommended for passage by this committee but, representing the individual views of the head of this committee, significance attaches to this proposal as constituting the first concrete program for the solutions of the problems at hand.

The first definite expression of the lower branch of the national legislature on the subject of a merchant marine policy came in November on the eve of the adjournment of the first or special session of the 66th Congress when the House committee on merchant marine and fisheries brought in a favorable report on the Greene Bill. This measure provides that all merchant ships and other property acquired by the President incident to the war-time emergency shall be transferred to the Shipping Board for management, operation, lease or sale. The Board is authorized to sell to citizens of the United States or aliens, other than enemy aliens, all vessels on hand, due provision being made for deferred payments. Vessels not sold by the Board shall be managed and operated by it or chartered or leased on a time basis or on terms of division of gross and net operating income. Under the stipulations of Section 12 of this Act the Shipping Board is instructed, as far as is consistent with the best interests of the United States, to discontinue the building of any ships and not to enter into any new contracts. The investments of the United States in the "various enterprises," including houses at shipbuilding plants, would be withdrawn as soon as possible.

The Greene Bill

The Greene Bill provides that all merchant ships and other property acquired by the President incident to the war-time emergency shall be transferred to the Shipping Board for management, operation, lease or sale. The Board is authorized to sell to citizens of the United States or aliens, other than enemy aliens, all vessels on hand, due provision being made for deferred payments. Vessels not sold by the Board shall be managed and operated by it or chartered or leased on a time basis or on terms of division of gross and net operating income. Under the stipulations of Section 12 of this Act the Shipping Board is instructed, as far as is consistent with the best interests of the United States, to discontinue the building of any ships and not to enter into any new contracts. The investments of the United States in "the various enterprises," including houses at shipbuilding plants, would be withdrawn as soon as possible.

Congressmen who have been conducting the inquiry into the operations of the United States Shipping Board have disclosed an especial curiosity with respect to defects that developed in American-built vessels, supposedly incident to the necessities of war-time construction. Robert L. Hague who was in the construction and repair department of the Shipping Board from the outset of operations was called upon to particularize on this score. Discussing the effort to reconcile ship design and construction to the necessities of commercial operation, Mr. Hague said:

Defects in American-Built Ships

"The design section of this department was mainly started to correct defects that all the people who operated vessels reported to us, and we in turn took them up and corrected them with Philadelphia, and later on, as we noticed how some of these vessels were working out in operation, we could design for future needs. We felt

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that in normal conditions Americans could operate in competition with foreign nations.

"There was a lot of difficulty regarding the workmanship in the actual construction of the ships. The trouble with the steel vessels mainly was due to the fact that we had so many vessels riveted and we did not have the riveters in the country to drive good rivets successfully; so the trouble with our steel vessels has been poor riveting, not due to any neglect but simply due to the fact that we did not have the riveters in the country and we had to build the vessels. With the wooden vessels the trouble has been poor calking, green lumber, unskilled workmen. Then, due to the fact that the hulls were being fabricated so rapidly, it was necessary to put in any machinery we could get and we put in such things as new turbines with reduction gearing. That has been one of our big figures in operation, the poor performance of these turbine reduction gears. That is why our repairs are running so high. We have, probably, 110 vessels in which defective turbine gearing will have to be replaced with new, successfully operating gearing."

Turning to the discussion of another angle of current operations in connection with the management of the fleet, this executive pointed out: "Repairs are the most troublesome part of our department. Formerly repairs were conducted on the cost-plus system. We abolished this and tried to put repairs on the same basis and handle them in just the same way as the big competing steamship companies would handle repairs. So far as possible, specifications are prepared and competitive bidding is secured, bearing in mind two things,—price and time.

Cost of Repairs

"Time is the essence of the contract and we so declare it and, in addition to competitive bids we make the man who is putting in a price state the number of calendar days he will do the job in, and we time pretty closely to that. We think that a ship is worth $1 per registered ton per day,—$1 per net registered ton for steel vessels and 50 cents per day for wooden vessels—and we insist upon liquidated damages for delay on that base price. I might say that 95 percent of the bidders realize that this is a way to protect them against their competitors, although they think the price is too high.

Mr. Hague went on to explain that in actual practice the full demurrage is insisted upon only in the case of contracts over $50,000. In the case of relatively small jobs it was found that enforcement of the terms would work injustice and also operated for the inflation of bids in order that bidders might play safe; consequently, for repairs of $25,000 and under there is an average for each day over the specified time (unless there is some reasonable excuse) of 33⅓ cents per net registered ton on steel vessels and half that on wooden vessels, while on jobs from $25,000 to $50,000 the figure is 66⅔ cents per net registered ton on steel and half that for wooden vessels. It was also explained that there are some occasions when it is impossible to get competitive bids and that there is a certain proportion of "voyage repairs"—jobs under $15,000—which are contracted for at the commercial rates of the shipyards, on a time-and-material basis. This last class of repair work has constituted, in the case of the Shipping Board, 10 percent of the total.

During the past few weeks the Congressional committee has pursued further the investigation into the marine insurance situation already referred to in these columns. The committee, or rather the subcommittee that has undertaken this particular responsibility, insists that it is not the intention to investigate marine insurance with any harmful ideas but to see if something can not be done to keep marine insurance, insofar as possible, in this country and to ascertain what conditions, if any, prevail to deter American fire insurance companies and other companies from going into the business. Along this line and with the idea of securing basic information, the subcommittee has sent out a number of questionnaires. The responses have been very satisfactory. Some of the information embodied in the replies may ultimately be made public but various contributors have asked that certain portions of their testimony shall be treated as confidential and this will be done. Congressman Edmonds, who is active in this investigation, recently remarked: "No one need fear that we are trying to make any destructive legislation. We are trying to make constructive legislation and trying to benefit these men who have and will and can build up the American merchant marine insurance."

Marine Insurance

Executives of various insurance companies have stated at Washington that if the grip which foreign companies hold on American marine insurance is to be broken it will be necessary to encourage a spirit of patriotism such as is claimed to exist in Great Britain. The Congressional investigators bemoan especially the tendency of American companies to cater primarily to cargo insurance and to neglect hull insurance, with the consequence that at least 50 percent of all American hull insurance is, according to the most reliable estimates, exported. More to the point, the American companies that have heretofore gone in for hull insurance have notified the Congressmen that, far from seeking to expand along this line, they are now making every effort to curtail this class of business on account of the competition with the foreign insurance market, which escapes all Government and State taxes.

The situation with respect to hull insurance is practically duplicated in the field of builders' risk insurance. Aside from the consideration of taxes, above mentioned, it also develops that a very large proportion of American builders' risk insurance is going to companies located in foreign countries because such companies may assume hazards which are forbidden to American companies by the laws of the various States in this country.

Disclaimer to the shipping and shipbuilding interests of any intention to enact embarrassing or oppressive legislation has likewise been made by the members of the merchant marine committee in connection with the consideration of a bill (H. R. 8422) dealing with the recording of mortgages on vessels and providing that maritime liens upon vessels for necessaries shall be subordinate to the liens of mortgages. There is a feeling among many shipbuilders, repairers, supply men, etc., that this bill presents a serious menace to their interests. Congressmen who favor the measure contend that the element of danger has been exaggerated. They have undertaken to point out to shipbuilding and repair interests that if their respective industries are to prosper means must be found to render safe and attractive the investment of funds in ships. It is pointed out that as matters now stand the trust companies of the country will not invest in bonds secured by ships; neither will such investment be made in the case of trust funds. The pending bill, which was introduced at the request of the United States Shipping Board, is supposed to remedy the situation reputed to exist as to the security of investments.

Protection for Ship Securities Sought

As explained to the committee by Ira A. Campbell, former admiralty counsel of the Shipping Board, who prepared the bill, it was drawn in the interest of two things:

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first, to better safeguard the Government's interest in the sale of its ships with deferred payments for the purchase price, and secondly, in the hope that the financial investors or the banking interests of the country will be willing to invest their money more freely in ship securities. The contention is that investment in shipping is now discouraged and curtailed by the circumstance that liens arising out of repairs, collisions, salvages, seamen's wages and cargo damage all come ahead of the mortgagee. The bill or at least some of its features have been opposed in discussions at Washington by J. B. Certer, representing the Skinner & Eddy Corporation of Seattle and J. E. Barnes, representing the Todd Shipyards Corporation, the J. F. Duthie Corporation and the Ames Company. The principles of the bill have been favored by R. G. Bickford of the Newport News Shipbuilding and Dry Dock Company, Malcolm D. Webster, representing the New York Shipbuilding Corporation, and others.

Of parallel interest to the bill above mentioned is another (H. R. 7124), which authorizes suits against the United States in Admiralty and which is now under consideration by the committee on the judiciary of the House of Representatives. The legislative innovation which the enactment of this measure would accomplish has been brought about in large part by the construction programme of the Shipping Board. It would allow suit to be brought against any Government ship,—of the merchant fleet, the United States Navy, the United States Army, etc., etc.

In the Congressional inquiry into the operations of the Shipping Board it was disclosed that the principal difficulties encountered in the actual construction of ships during the war were due to the lack of skilled and experienced workmen. In the case of steel ships, the chief trouble was poor riveting—not because of neglect, but because there were not enough skilled ship riveters in the country to do the enormous amount of work required. In the case of wooden vessels the trouble came from poor calking, green lumber and unskilled workmen. After the ships were built the chief cause of trouble in operation was found to be in defective turbine reduction gears. At one time the Shipping Board had no less than 110 vessels in which it was necessary to replace defective turbine reduction gears.

House Committee Reports Favorably on the Greene Bill

In November, on the eve, as it were, of the adjournment of the first or special session of the 66th Congress, the committee on merchant marine and fisheries of the House of Representatives brought in a favorable report on the bill of Congressman Greene of Massachusetts referred to above, which provides for the promotion and maintenance of the American merchant marine. This measure thus became the accepted and approved expression of the lower branch of the national legislature on the subject of a merchant marine policy and whereas it was apparent that the Senate could not give expression to its views on the same general subject until December or later, the leaders in the House took the attitude that this body at least had done its duty in authorizing a definite programme with respect to the American merchant marine and the shipbuilding industry.

According to the report which accompanied the Greene bill when the merchant marine committee recommended its passage, that body found that in order to establish regularity in the future conduct of the numerous different shipping activities, operated either by order of the President through emergency legislation or by the original shipping act, it is essential that all of these operations be concentrated under one authority. This explains why the committee programme embodied both the repeal of existing legislation rendered unnecessary by the ending of the war and new legislation for future operation.

The merchant marine committee has defended vigorously the policy whereby the Shipping Board is instructed to sell available merchant tonnage, taking into consideration in the sale price the prevailing market prices for vessels of a like character, but disregarding the war cost of the vessels involved. It is admitted that under certain circumstances this will undoubtedly cause considerable loss to the Government, but it is contended that this is to be condoned in view of the fact that with the present building programme of the leading maritime nations of the world there must come a time before long when all the tonnage necessary for the carrying of the world's trade will be supplied. The committee foresees that when that time arrives shipping property will inevitably be depreciated to a level considerably lower than the war cost to the Government.

Sale of Surplus Ships

Figures have been compiled by the Congressional authority in support of its authorization for the sale of surplus ships at open market prices. Based upon the showing of Lloyd's Register as of date of July 1, 1919, it was computed that 8,000,000 tons of ocean-going vessels were under construction upon the ways of the different nations. This added to an existing ocean-going tonnage of 49,000,000 tons gave a total of 58,000,000 tons available for operation at a period within the next few months, as compared with less than 50,000,000 tons available in 1914. The committee likewise reached the conclusion that the disturbed trade conditions now existing would further tend to cause shipping tonnage to equal the demand for it.

It has been pointed out that the only vessels to be disposed of under its plan to foreign interests are the smaller vessels which would not prove desirable in ordinary commercial work, but which are well adapted to certain classes of coastwise trade. A limitation of five years placed upon the operation activities of the Shipping Board in the conduct of the Government-owned fleet is deemed to allow the Board ample opportunity to establish lines and to handle any tonnage that may be offered.

In granting to the Shipping Board the privilege of maintaining its own insurance fund covering the tonnage under its control the merchant marine committee took occasion to indicate pointedly that there was no compulsion in this "if it is found advantageous to utilize this insurance in building up American merchant marine insurance companies," thereby touching upon a subject regarding which, as has been indicated in these columns, Congress has shown an increasing solicitude. Indeed, the merchant marine committee has virtually conveyed a hint to the Shipping Board in calling attention to the fact that two-thirds of the marine insurance of this country is today written in foreign companies and expressing the thought that the Shipping Board may find some way to utilize its patronage to build up American companies to such an extent that the enormous expenditures in premiums in this line can be retained in the United States.

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The Propulsive Efficiency of Single-Screw Cargo Ships*

Effect of Varying Amount of Parallel Middle Body and Longitudinal Coefficient Simultaneously With Constant Over-All Dimensions

BY COMMANDER WILLIAM MC ENTEE, CONSTRUCTION CORPS, U. S. N.

IN A PAPER** read before the last meeting of the Society giving the results of a series of experiments made at the U. S. Experimental Model Basin with models of single-screw cargo ships it was shown among other things that for good propulsive efficiency it was necessary to have the run finer than the entrance, and for vessels of this class having a parallel middle body equal to about one-third the length of the ship, the minimum power is required when the fore-and-aft position of the parallel middle body is such that about two-thirds of it is forward of the midship section and one-third abaft it. Those results, which it is believed were the first of any extensive series of experiments with self-propelled models of single-screw ships to be made public, were confirmed by a somewhat similar series of tests made at Clydebank on models of vessels of the same general class. The results of the latter tests were presented in a paper† by Mr. James Semple before the Institution of Naval Architects in April, 1919.

In view of the importance of this class of vessel it was considered desirable to extend the investigation, and the present paper contains the results of the tests of five additional models, the characteristics of which are given in the following table:

TABLE 1

Model No.	Longitudinal coefficient	% of parallel middle body	Run in % of length	Displacement —tons
2181	0.74	30	38.70	12,341
2182	0.76	35	37.03	12,675
2183	0.78	40	35.37	13,009
2184	0.80	45	33.70	13,344
2185	0.82	50	32.03	13,678

*Paper read before the Society of Naval Architects and Marine Engineers, New York, November 14, 1919.

**"Variation of Shaft Horsepower, Propeller Revolutions and Propulsive Coefficient with Longitudinal Position of the Parallel Middle Body in a Single-Screw Cargo Ship."

†"Experiments on Full Cargo Ship Models."

The lines of the parent form, Model No. 2023, are shown in Fig. 1. In Fig. 2 are shown the sectional area curves for the five models and the parent form.

The investigation had for its object determination of the effect of varying the amount of parallel middle body and the longitudinal coefficient simultaneously while maintaining the principal over all dimensions. In other words, the investigation sought to obtain data from which it would be possible at any given practicable speed for a cargo carrier to determine the economic possibilities of increasing the displacement by increasing the parallel middle body and longitudinal coefficient. A great many vessels of this character now built have coefficients ranging from 0.78 to 0.80, and the question to be determined was the economic limit of fullness so far as coefficient and displacement are concerned for a vessel of a given length, beam, and draft. In the five models tested the longitudinal coefficient varied by increments of 0.02 from 0.74 to 0.82.

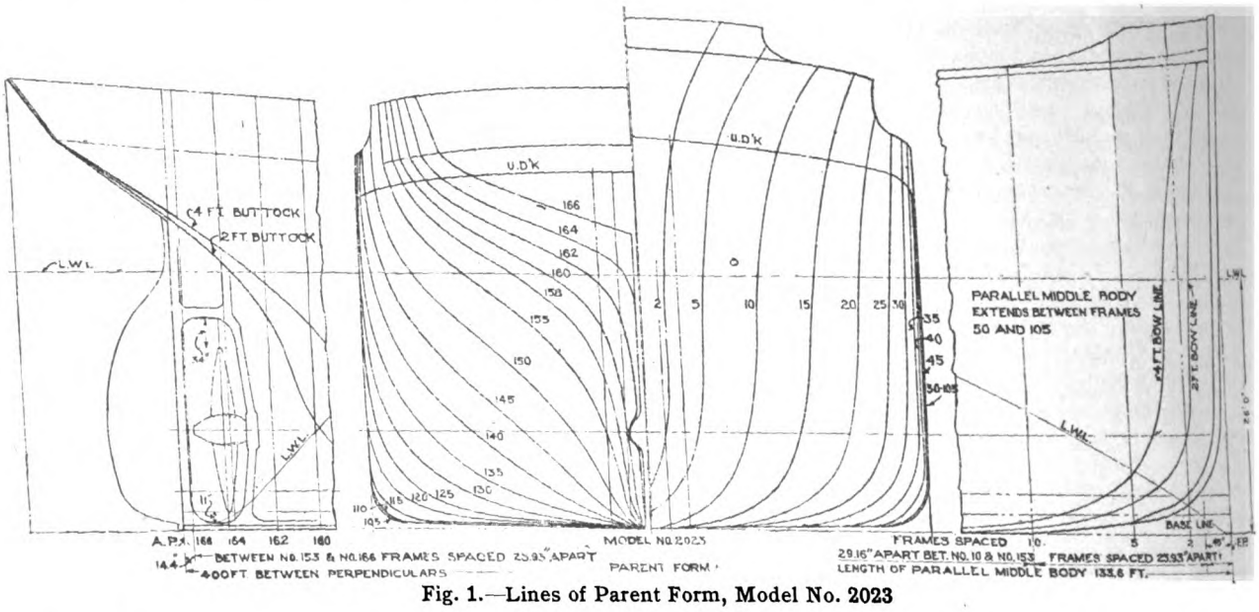
U.D'K
4 FT BUTTOCK
2 FT BUTTOCK
L.W.L
PARALLEL MIDDLE BODY EXTENDS BETWEEN FRAMES 50 AND 105
4 FT BOW LINE
2 FT BOW LINE
BASE LINE
A.P.
BETWEEN NO.153 & NO.166 FRAMES SPACED 25.93" APART
400 FT BETWEEN PERPENDICULARS
MODEL NO.2023
PARENT FORM
FRAMES SPACED 29.16" APART BET. NO.10 & NO.153 FRAMES SPACED 25.93" APART
LENGTH OF PARALLEL MIDDLE BODY 133.6 FT.

Fig. 1.—Lines of Parent Form, Model No. 2023

As mentioned in last year's paper, previous experiments at the Experimental Model Basin have shown that, for a single-screw cargo ship of about 0.78 coefficient, it is desirable to use a parallel middle body of about one-third the length. For simplicity in construction, however, it is desirable to use a somewhat greater length of parallel middle body. It is possible to use with this coefficient a parallel middle body of about 40 percent of the ship's length without much sacrifice in power. This consideration determined the extent of parallel middle body for each model as given in Table 1. Comparison of results of the present series with last year's results shows that an increase of parallel middle body from 33 percent to 42 percent causes an increase in effective horsepower of but 3 percent only.

In order to keep the run fine, the fore-and-aft distribution of the parallel middle body was retained the same as had previously shown the best results; that is, one-third

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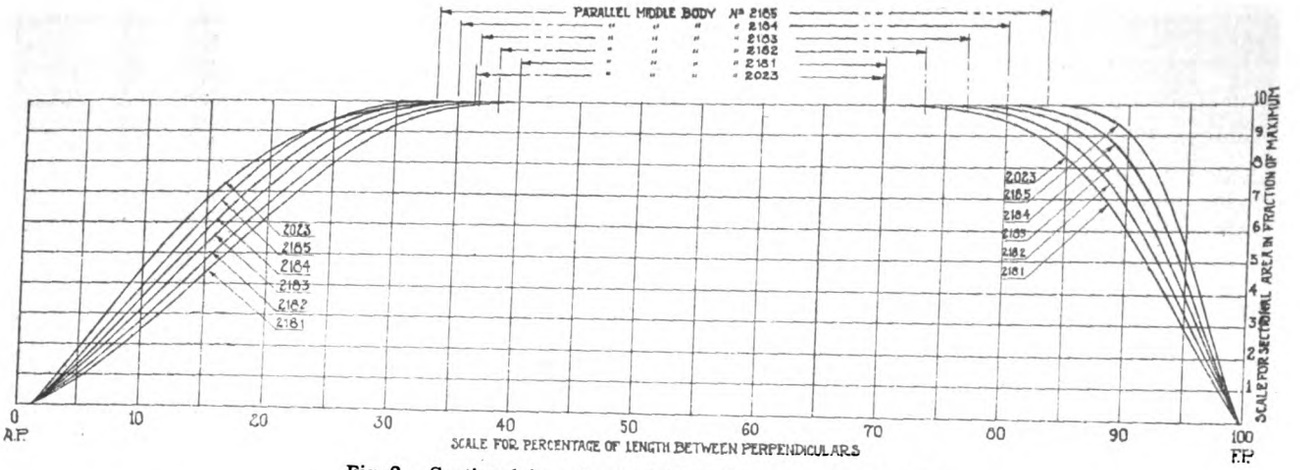

Fig. 2.—Sectional Area Curves of Five Models and Parent Form

abaft the midship section and two-thirds forward of it. This distribution possibly gives for the higher coefficient a model which is too bluff at the entrance, especially at the higher speeds. For the lower speeds, the distribution of sectional area seems to be satisfactory, particularly as regards eddying at the stern, which is liable to occur with vessels of full coefficient.

The following are the dimensions of the propeller used in the experiments and also the dimensions expanded to the ship scale:

	Model	Ship
Diameter	10.125 inches	16 feet 7 inches
Pitch	9.0 inches	14 feet 9 inches

Pitch ratio	0.889
Mean width ratio	0.20
Number of blades	3
Ratio of projected to disk area	0.266
Blade thickness fraction	0.04

The propeller had three blades of Taylor's standard form.

The propeller characteristics were obtained by separate tests of the propeller model run in free water, that is, in a separate apparatus where the propeller shaft projected well ahead, so that the propeller ran in water undisturbed by the action of the testing apparatus. The same motor dynamometer was used for tests as was used for the self-propulsion tests, the only difference being that the propeller shaft was coupled to the forward end of the armature shaft instead of the after end.

The characteristics of the propeller are given in Fig. 3. The thrust constant, C_t, and the torque constant, C_q, are plotted on [illegible]minal slip following the method used by Schaffran.* These constants, which are in non-dimensional form, lend themselves well to the analysis of self-propulsion experiments and to the extension of the results to the full-size ship.

The results of the investigation are given in Figs. 4, 5 and 6. An examination of the estimated horsepower curves and the shaft horsepower curves for the various models shows, as was to be expected, wide variation in power requirements, especially at higher speeds. For example, at 11 knots passing from Model 2181 longitudinal coefficient 0.74 to Model 2185 longitudinal coefficient 0.82, with a change in displacement of 1,337 tons, or 10.8 percent, increases the effective horsepower from 1,165 to 1,585 or 36 percent, while the shaft horsepower is increased by 950 or 54 percent. In this range the percentage increase in effective horsepower required is about three and one-half times as much as the increase in displacement, while the increase in shaft horsepower is five times as great as that in displacement. At a speed of 11 knots the increased displacement is obtained by an apparently unwarranted increase in power. This results from the fact that the natural increase in effective horsepower resulting from the larger displacement and coefficient is magnified or augmented by an accompanying fall in the propulsive coefficient from 0.665 to 0.587.

In the tests the same propeller was used on all models, and it may be considered that the propeller is too small for the ship represented by Model 2185, as the revolutions per minute have increased from 84.5 to 93.2. This is to some extent true, but separate estimates indicate that if a propeller of different diameter or pitch were fitted to

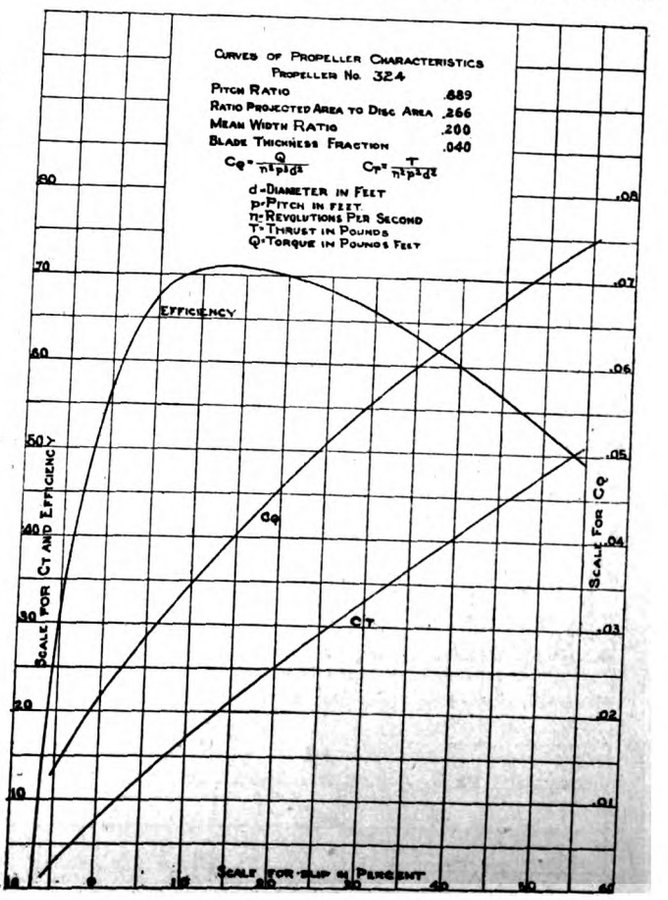

Fig. 3.—Characteristics of Propeller

*"Systematische Propellerversuche;" K. Schaffran, *Schiffbau*, September 22, 1915.

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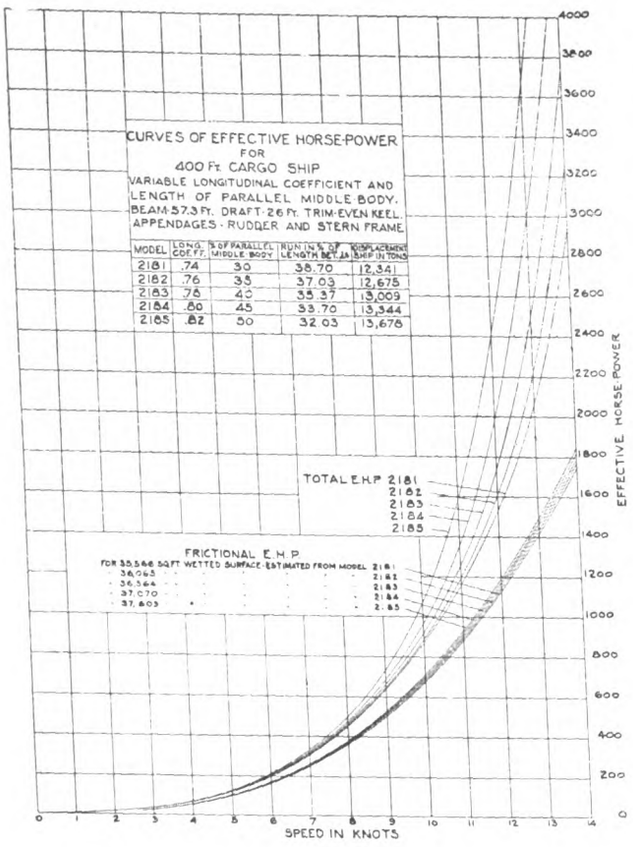
CURVES OF EFFECTIVE HORSE-POWER
FOR
400 Ft. CARGO SHIP
VARIABLE LONGITUDINAL COEFFICIENT AND
LENGTH OF PARALLEL MIDDLE BODY.
BEAM-57.3 Ft. DRAFT-26 Ft. TRIM-EVEN KEEL.
APPENDAGES - RUDDER AND STERN FRAME.
MODEL | LONG. COEFF. | % OF PARALLEL MIDDLE BODY | RUN IN % OF LENGTH BET. ⊥s | DISPLACEMENT SHIP IN TONS
2181 | .74 | 30 | 38.70 | 12,341
2182 | .76 | 35 | 37.03 | 12,675
2183 | .78 | 40 | 35.37 | 13,009
2184 | .80 | 45 | 33.70 | 13,344
2185 | .82 | 50 | 32.03 | 13,678
TOTAL E.H.P 2181 2182 2183 2184 2185
FRICTIONAL E.H.P
FOR 35,546 SQ.FT. WETTED SURFACE-ESTIMATED FROM MODEL 2181
36,063 2182
36,564 2183
37,070 2184
37,603 2185
EFFECTIVE HORSE POWER
SPEED IN KNOTS

Fig. 4

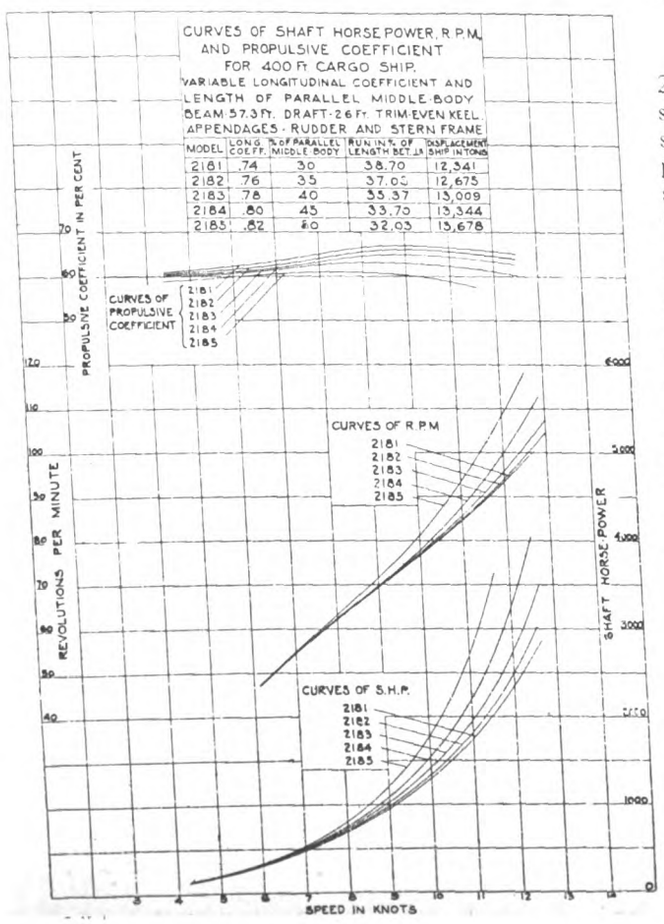
CURVES OF SHAFT HORSE POWER, R.P.M.
AND PROPULSIVE COEFFICIENT
FOR 400 Ft. CARGO SHIP.
VARIABLE LONGITUDINAL COEFFICIENT AND
LENGTH OF PARALLEL MIDDLE-BODY
BEAM-57.3 Ft. DRAFT-26 Ft. TRIM-EVEN KEEL
APPENDAGES - RUDDER AND STERN FRAME
MODEL | LONG. COEFF. | % OF PARALLEL MIDDLE BODY | RUN IN % OF LENGTH BET. ⊥s | DISPLACEMENT SHIP IN TONS
2181 | .74 | 30 | 38.70 | 12,341
2182 | .76 | 35 | 37.03 | 12,675
2183 | .78 | 40 | 35.37 | 13,009
2184 | .80 | 45 | 33.70 | 13,344
2185 | .82 | 50 | 32.03 | 13,678
CURVES OF PROPULSIVE COEFFICIENT 2181 2182 2183 2184 2185
PROPULSIVE COEFFICIENT IN PER CENT
CURVES OF R.P.M. 2181 2182 2183 2184 2185
REVOLUTIONS PER MINUTE
CURVES OF S.H.P. 2181 2182 2183 2184 2185
SHAFT HORSE POWER
SPEED IN KNOTS

Fig. 5

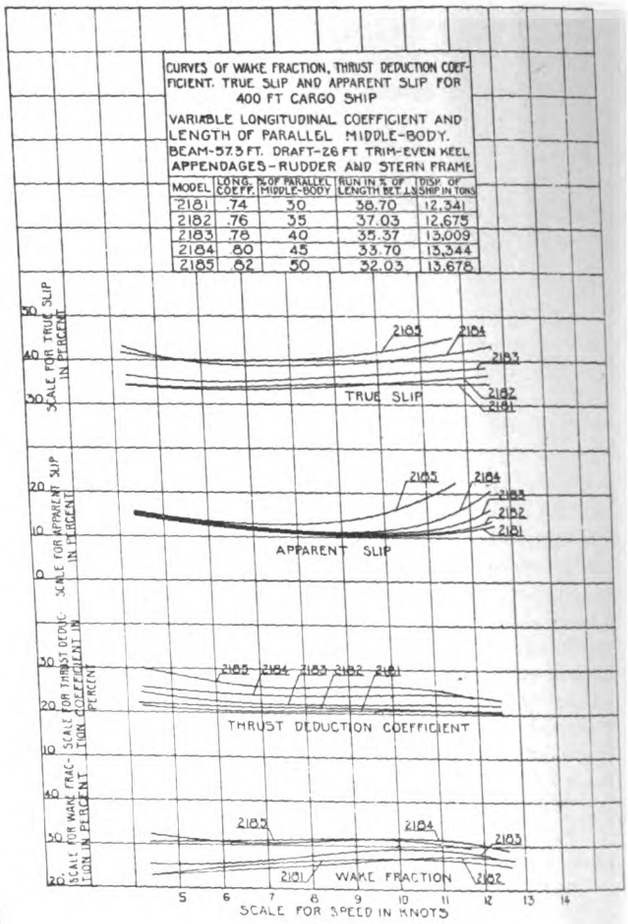
CURVES OF WAKE FRACTION, THRUST DEDUCTION COEFFICIENT. TRUE SLIP AND APPARENT SLIP FOR
400 FT CARGO SHIP
VARIABLE LONGITUDINAL COEFFICIENT AND
LENGTH OF PARALLEL MIDDLE-BODY.
BEAM-57.3 FT. DRAFT-26 FT. TRIM-EVEN KEEL
APPENDAGES-RUDDER AND STERN FRAME
MODEL | LONG. COEFF. | % OF PARALLEL MIDDLE-BODY | RUN IN % OF LENGTH BET. ⊥s | DISP. OF SHIP IN TONS
2181 | .74 | 30 | 38.70 | 12,341
2182 | .76 | 35 | 37.03 | 12,675
2183 | .78 | 40 | 35.37 | 13,009
2184 | .80 | 45 | 33.70 | 13,344
2185 | .82 | 50 | 32.03 | 13,678
SCALE FOR TRUE SLIP IN PERCENT
TRUE SLIP
SCALE FOR APPARENT SLIP IN PERCENT
APPARENT SLIP
SCALE FOR THRUST DEDUC-TION COEFFICIENT IN PERCENT
THRUST DEDUCTION COEFFICIENT
SCALE FOR WAKE FRAC-TION IN PERCENT
WAKE FRACTION
SCALE FOR SPEED IN KNOTS

Fig. 6

2185 for the purpose of reducing the revolutions to 84.5, such change would make but little change in the propulsive coefficient, not over one percent, so for all practical purposes the models may be compared on the basis of the shaft horsepower curves shown in Fig. 5, without taking the revolutions into consideration.

As another comparison of these results, it is interesting to consider the effect of increasing the longitudinal coefficient and displacement of the ship represented by Model 2183. The curves show that at a speed of 11 knots an increase of longitudinal coefficient from 0.78 to 0.80 with a corresponding increase in displacement of 335 tons or 2.57 percent requires an 8 percent increase in effective horsepower and 12.27 percent increase in shaft horsepower. Of the increased displacement, only a part would be available as cargo-carrying capacity, depending upon the necessary increase in the weight of the hull, machinery, and fuel. On a given trade route, with a knowledge as to the cost of fuel and other expenses proportional to the power, it may readily be determined whether the additional cargo carried for the additional displacement would be economically possible with the increased power charges.

In Fig. 6 are shown the curves of wake fraction, thrust deduction coefficient, apparent slip and true slip for the ships. In extending the results of the model experiments to the full-sized ships it has been assumed that the wake fraction and thrust deduction coefficient for the ships are the same as for the models.

As the American practice in defining the wake as a percentage of the ship's speed varies from that followed in Great Britain, the following definitions of the thrust deduction coefficient and the wake fraction are given:

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$$t = \frac{T-R}{T}; w = \frac{V-V'}{V},$$

in which T is the thrust of the propeller, R the resistance of the ship, V the speed of the ship, V' the speed of advance of the propeller in the water in which it works.

With regard to the shaft horsepower required for the ships represented by the different models, it should be noted that the curves show what may be expected under trial conditions, that is, with a clean, freshly painted bottom and a smooth bronze propeller running in smooth water. To maintain the same sea speed over considerable periods, it is necessary to allow a margin of power to cover the increased resistance due to average sea and weather conditions and a moderate amount of fouling of bottom, which occurs between each docking and painting.

Summing up the results of both series of experiments, it appears safe to conclude that, for a well-designed hull with a propeller running at about 90 revolutions per minute, a hull efficiency of 1.09 and a propulsive efficiency of 0.65 may be expected in a single-screw cargo ship.

Economical Cargo Ships*

Cost of Operation at Four Different Speeds of Four Standard Vessels of Different Sizes

BY ALFRED J. C. ROBERTSON

THE circumstances of the late war and the necessity of largely rebuilding the shipping trade of the world have called the attention of naval architects to the need of a careful mathematical and scientific analysis of the cost of operation of ships, and, as a result, several investigators have recently given us the benefit of valuable papers on the subject. Particular reference might be made to the paper by Mr. John Anderson to the Institution of Naval Architects, London, March 20, 1918; by Alexander Urwin to the Northeast Coast Institution of Engineers and Shipbuilders, January 14, 1919; and by Messrs. G. S. Baker and J. L. Kent to the Institution of Engineers and Shipbuilders in Scotland, February 18, 1919.

Mr. Anderson, in his paper, devotes special attention to working out a theory of operating efficiency based on the number of cargo derricks and winches that can be used and the derrick speed which can be employed in loading or unloading vessels. Mr. Urwin tabulates in a very methodical manner the various elements that go to produce an efficiency figure, and has given us one or two examples worked out. Messrs. Baker and Kent have also treated the matter in this way, but, in addition, give considerable attention to the actual ship form for economical movement of freight.

In the opinion of the writer greater progress could probably be made if naval architects were able to place before ship operators the actual operating costs under certain assumed conditions and with various combinations of size, speed and form of ship. Figures compiled in this way showing the cost of operation for certain German ships on four stated routes were published in SHIPBUILDING AND SHIPPING RECORD of January 2, 1918, and figures have also been compiled by the United States Shipping Board covering the operation of certain ships over various routes. In each case, however, these figures were for vessels varying in their general characteristics, and it appears to the writer that any true comparison can only be made if the variation in the characteristics of the vessels is directly limited to that feature which it is desired to investigate. He has therefore prepared some calculations in this direction and takes the liberty of placing before the Society of Naval Architects and Marine Engineers such figures and results as he thinks may prove of value.

The method adopted has been to take vessels of four different sizes, of standard proportions, and to work out on the same basis the first cost and the cost of operation for each vessel at each of four different speeds. In addition, the writer has investigated particular features in the cost of operation for one or more sizes of ship. The scope of this series of calculations for an assumed length of route of 3,500 nautical miles between fueling ports is shown herewith, each size of ship being investigated for 10 knots, 11 knots, 12 knots and 13 knots sea speed, using oil as fuel, except as noted:

(*A*) Block coefficient chosen for each specific speed.

1. With minimum port detention; length of ship, 350 feet, 400 feet, 450 feet, and 500 feet.
2. Minimum port detention, coal burning; length of ship, 500 feet.
3. Minimum port detention, concrete ship; length of ship, 500 feet.
4. Double port detention; length of ship, 350 feet and 500 feet.
5. Minimum port detention, with 10 percent increased resistance, 500-foot ship.

(*B*) Fixed block coefficient for all speeds.

6. Minimum port detention; fine model, 500-foot ship.
7. Minimum port detention; full model, 500-foot ship.

Each of these ships was investigated for fuel rates of $6.00 and $12.00 with tonnage dues, and with a fuel rate of $6.00 figures were also calculated without tonnage dues. In addition to the above calculations, another series was made with a steaming distance of 7,000 nautical miles between ports, but as the character of the results was the same throughout, the investigation for this length of run was not made so complete. Such figures as the author thinks would be of interest for the 3,500 nautical mile haul are given in Plate 1.

In order to extend these calculations, a very considerable number of assumptions had to be made, as follows:

(*a*) *Proportions.*—The length of the vessel was taken as the waterline length, which would also be the length between perpendiculars for twin-screw vessels. The length between perpendiculars for single-screw vessels would be somewhat greater than the figures given.

The breadth molded was taken as equal to .10 of the length on waterline, plus 14 feet, this proportion giving ample beam for stability even with a considerable amount of superstructure.

The load draft in each case was chosen to give a breadth upon draft ratio of 2.25, which is approximately the best ratio for economical propulsion.

(*b*) *Speed and Power.*—The speed in each case is such

*Paper read before the Society of Naval Architects and Marine Engineers, New York, November 13, 1919.

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Plate 1.—Data for 3,500 Nautical Mile Voyage

			350-FOOT SHIPS, MINIMUM PORT DETENTION				350-FOOT SHIPS, DOUBLE PORT DETENTION				400-FOOT SHIPS, MINIMUM PORT DETENT.				450-FOOT SHIPS, MINIMUM DETENTION			
1	COLUMN No. 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2	LENGTH ON WATERLINE	FEET	350'-0	350'-0"	350'-0"	350'-0"	350'-0"	350'-0"	350'-0"	350'-0"	400'-0"	400'-0"	400'-0"	400'-0"	450'-0"	450'-0"	450'-0"	450'-0"
3	BREADTH	"	49'-0"	49'-0"	49'-0"	49'-0"	49'-0"	49'-0"	49'-0"	49'-0"	54'-0"	54'-0"	54'-0"	54'-0"	55'-0"	55'-0"	55'-0"	55'-0"
4	LOAD DRAFT	"	21'-5½	21'-5½	21'-5½	21'-5½	21'-5½	21'-5½	21'-5½	21'-5½	24'-0"	24'-0"	24'-0"	24'-0"	26'-2½	26'-2½	26'-2½	26'-2½
5																		
6	SPEED ON SERVICE	KNOTS	10.0	11.0	12.0	13.0	10.0	11.0	12.0	13.0	10.0	11.0	12.0	13.0	10.0	11.0	12.0	13.0
7	SPEED-LENGTH RATIO $\frac{V}{\sqrt{L}}$	C_M	.535	.587	.641	.695	.535	.587	.641	.695	.50	.55	.60	.65	.471	.518	.565	.613
8	BLOCK COEFFICIENT	TONS	.768	.740	.712	.689	.768	.740	.712	.689	.785	.762	.734	.711	.809	.782	.755	.731
9	LOAD DISPLACEMENT	I.H.P.	8,196	7,897	7,599	7,353	8,196	7,897	7,599	7,353	11,686	11,286	10,872	10,531	16,090	15,553	15,016	14,539
10	INDICATED HORSE POWER	TONS	1,566	1,970	2,470	3,028	1,566	1,970	2,470	3,028	2,021	2,515	3,121	3,862	2,600	3,200	3,877	4,749
11	RATIO, TONS DISPL. PER I.H.P.	TONS	5.234	4.008	3.076	2.428	5.234	4.008	3.076	2.428	5.782	4.487	3.483	2.727	6.188	4.860	3.873	3.061
12																		
13	WEIGHT OF HULL AND OUTFIT	TONS	2,108	2,081	2,055	2,034	2,108	2,081	2,095	2,034	3015	2,978	2941	2,909	4,166	4,119	4,069	4,026
14	WEIGHT OF PROPELLING M/CY	"	392	492	618	757	392	492	618	757	505	629	780	966	650	800	969	1,187
15	TOTAL DEADWEIGHT	"	5,696	5,324	4,926	4,562	5,696	5,324	4,926	4,562	8,166	7,679	7,151	6,656	11,274	10,634	9,978	9,326
16	RATIO: DEADWEIGHT TO DISPL.	"	.695	.675	.648	.620	.695	.675	.648	.620	.698	.680	.658	.632	.701	.684	.664	.641
17																		
18	COST OF HULL AND OUTFIT	$	580,750	574,000	567,500	562,250	580,780	574,000	567,500	562,250	833,750	824,500	815,250	807,250	1,155,250	1,143,500	1,131,000	1,120,250
19	" " PROPELLING MACHINERY	"	203,580	256,100	321,100	393,640	203,580	256,100	321,100	393,640	262,730	326,950	405,730	502,060	338,000	416,000	504,010	617,370
20	" " SHIP	"	784,330	830,100	888,600	955,890	784,330	830,100	888,600	955,890	1,096,480	1,151,450	1,220,980	1,309,310	1,493,250	1,559,500	1,635,000	1,737,620
21	" " " PER TON DEADWT	"	137.76	155.91	180.89	209.53	137.76	155.91	180.89	209.53	134.27	143.95	170.74	196.71	132.46	146.68	163.85	186.33
22																		
23	FUEL CONSUMED PER VOYAGE	TONS	265	300	342	384	265	320	362	404	346	387	436	494	446	494	545	611
24	STORES AND FRESH WATER	"	132	150	171	152	132	160	181	202	173	193	218	247	223	247	272	305
25	CARGO DEADWEIGHT	"	5295	4874	4413	3986	5265	4844	4383	3956	7,647	7,099	6,497	5,915	10,605	9,833	9,161	8,410
26																		
27	TIME ON VOYAGE	DAYS	14.58	13.26	12.15	11.22	14.58	13.26	12.15	11.22	14.58	13.26	12.15	11.22	14.58	13.26	12.15	11.22
28	" IN PORT	"	5.15	5.15	5.15	5.15	10.30	10.30	10.30	10.30	5.80	5.80	5.80	5.80	6.50	6.50	6.50	6.50
29	" FOR ANNUAL OVERHAUL	"	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
30																		
31	NUMBER OF TRIPS PER YEAR		16.97	18.20	19.36	20.46	13.46	14.22	14.92	15.57	16.44	17.58	18.66	19.68	16.89	16.95	17.96	18.90
32	TIME ON VOYAGE PER YEAR	DAYS	247.4	241.3	235.2	229.6	196.4	188.5	181.3	174.6	239.7	233.1	226.7	220.8	231.7	224.8	218.2	212.1
33	TIME IN PORT PER YEAR	"	117.6	123.7	129.8	135.4	166.6	176.5	183.7	190.4	125.3	131.9	138.5	144.2	133.3	140.2	146.8	152.5
34	PERCENTAGE TIME UNDER WAY	%	67.8	66.1	64.4	62.9	53.8	51.6	49.7	47.8	65.7	63.9	62.1	60.5	63.5	61.6	59.8	58.1
35																		
36	COST OF MANNING AND MANAGET P.A.	$	72,915	72,915	72,915	72,915	72,915	72,915	72,915	72,915	81,300	81,300	81,300	81,300	98,490	98,490	98,490	98,490
37	DEPRECIATION, INSURANCE, UPKEEP, P.A.	"	101,963	107,513	115,518	124,266	101,963	107,513	115,518	124,266	142,542	149,688	158,727	170,210	194,122	202,736	212,550	226,891
38	FUEL OIL @ $6.00 A TON, PER ANNUM	"	26,588	32,760	39,727	47,141	23,017	27,302	32,406	37,742	34,130	40,822	48,815	58,332	42,322	50,241	58,729	69,290
39	DUES @ $1.60 PER NETT TON, P.A.	"	69,543	71,854	73,549	75,211	55,159	56,155	56,681	57,235	96,059	99,204	101,436	103,615	127,835	131,803	134,844	137,384
40																		
41	ANNUAL COST OF OPERATION } FUEL @ $6.00 NO DUES	$	201,866	213,588	228,160	244,322	197,895	208,130	220,839	234,922	257,972	271,810	288,842	309,842	335,134	351,466	369,769	393,671
42	" " " WITH DUES	"	271,409	285,442	301,703	319,535	283,054	264,285	277,520	292,158	354,031	371,014	390,278	413,457	462,969	483,269	504,613	532,035
43	" " @ $12.00 " "	"	298,357	318,202	341,436	366,674	276,071	291,587	309,926	329,900	388,161	411,836	439,093	471,789	505,491	533,510	563,342	600,345
44																		
45	CARGO MOVED P.A. PER $1,000,000	TONS	114,650	106,863	96,146	81,553	90,422	82,980	73,592	64,437	114,655	108,385	99,344	88,907	112,635	107,825	100,742	91,475
46																		
47	COST OF OPERATING { $6 FUEL, NO DUES	$	287,374	287,304	256,763	255,596	262,311	250,729	248,525	245,763	235,273	236,065	236,565	236,645	224,433	225,371	226,158	226,557
48	PER ANNUM PER MILLION { $6 " WITH "	"	340,039	343,864	339,533	334,278	322,637	318,377	312,311	305,640	322,879	322,215	319,643	315,782	310,041	309,887	308,632	305,622
49	DOLLARS INVESTMENT { $12 " " "	"	380,440	383,329	384,240	383,594	351,983	351,267	348,780	345,123	354,006	357,667	359,623	360,334	338,517	342,103	344,551	345,498
50																		
51	PROFIT P.A. PER $1,000,000 { $6 FUEL, NO DUES	$	298,678	260,981	209,545	139,936	186,236	151,724	108,396	66,756	320,804	280,608	245,253	194,554	322,817	296,125	262,441	217,037
52	INVESTMENT @ $6.00 PER { $6 " WITH "	"	210,013	174,421	126,775	61,254	115,910	84,076	44,610	6,875	233,198	203,452	162,175	115,417	257,203	211,609	172,967	128,032
53	TON, LESS $17 SALVAGE @ 10% CONN. { $12 " " "	"	176,612	154,556	82,068	11,938	86,564	51,186	8,141	Loss 32,604	202,071	168,000	122,195	70,865	208,783	172,393	144,048	98,156
54																		
55																		

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Plate 1.—(Continued)

500-FOOT SHIPS, MINIMUM DETENTION				500-FOOT SHIPS, DOUBLE DETENTION				500-FOOT SHIPS, 10% GREATER POWER				500-FOOT SHIP, BLOCK COEFF. .750				500-FOOT SHIP, BLOCK COEFF .825			
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"	500'-0"
64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"	64'-0"
28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼	28'-5¼
10.0	11.0	12.0	13.0	10.0	11.0	12.0	13.0	10.0	11.0	12.0	13.0	10.0	11.0	12.0	13.0	10.0	11.0	12.0	13.0
.447	.491	.536	.581	.447	.491	.536	.581	.447	.491	.536	.581	.447	.491	.536	.581	.447	.491	.536	.581
.825	.80	.775	.750	.825	.80	.775	.750	.825	.80	.775	.750	.750	.750	.750	.750	.825	.825	.825	.825
21.452	20.802	20.152	19.500	21.452	20.802	20.152	19.500	21.452	20.802	20.152	19.500	19.500	19.500	19.500	19.500	21.452	21.452	21.452	21.452
3.254	3.994	4.825	5.828	3.254	3.994	4.825	5.828	3.579	4.393	5.308	6.411	2.582	3.460	4.519	5.828	3.254	4.032	5.935	8.215
6.592	5.208	4.176	3.345	6.592	5.208	4.176	3.345	5.993	4.735	3.797	3.041	7.552	5.636	4.315	3.346	6.592	5.320	3.614	2.611
5.626	5.568	5.506	5.448	5.626	5.568	5.506	5.448	5.626	5.568	5.506	5.448	5.448	5.448	5.448	5.448	5.626	5.626	5.626	5.626
.814	.998	1.206	1.457	.814	.998	1.206	1.457	.895	1.098	1.327	1.603	1.457	1.457	1.457	1.457	2.054	2.054	2.054	2.054
15.012	14.236	13.440	12.595	15.012	14.236	13.440	12.595	14.931	14.136	13.319	12.449	12.595	12.595	12.595	12.595	13.772	13.772	13.772	13.772
.700	.684	.666	.646	.700	.684	.666	.646					.646	.646	.646	.646	.642	.642	.642	.642
1,562,750	1,548,250	1,532,750	1,518,250	1,562,750	1,548,250	1,532,750	1,518,250	1,562,750	1,548,250	1,532,750	1,518,250	1,518,250	1,518,250	1,518,250	1,518,250	1,562,750	1,562,750	1,562,750	1,562,750
423,020	519,220	627,250	757,640	423,020	519,220	627,250	757,640	465,323	571,142	685,375	833,404	757,640	757,640	757,640	757,640	1,067,950	1,067,950	1,067,950	1,067,950
1,985,770	2,067,470	2,160,000	2,275,890	1,985,770	2,067,470	2,160,000	2,275,890	2,028,073	2,119,392	2,222,725	2,351,654	2,275,890	2,275,890	2,275,890	2,275,890	2,630,700	2,630,700	2,630,700	2,630,700
132^{27}	145^{33}	160^{71}	180^{67}	132^{27}	145^{33}	160^{71}	180^{67}	135^{62}	149^{32}	166^{93}	188^{39}	180^{47}	180^{67}	180^{67}	180^{67}	191^{03}	191^{03}	191^{03}	191^{03}
558	620	678	751	583	670	728	801	614	682	746	826	454	543	640	751	553	623	824	1038
279	310	339	375	291	335	364	400	307	341	373	413	227	271	320	375	279	312	412	519
14.175	13.306	12.423	11.469	14.138	13.231	12.348	11.394	14.010	13.113	12.200	11.210	11.914	11.781	11.635	11.469	12.934	12.837	12.536	12.218
14.58	13.26	12.15	11.22	14.58	13.26	12.15	11.22	14.58	13.26	12.15	11.22	14.58	13.26	12.15	11.22	14.58	13.26	12.15	11.22
7.25	7.25	7.25	7.25	14.50	14.50	14.50	14.50	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25	7.25
30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
15.34	16.33	17.26	18.14	11.52	12.07	12.57	13.02	15.34	16.33	17.26	18.14	15.34	16.33	17.26	18.14	15.34	16.33	17.26	18.14
223.7	216.5	209.7	203.5	168.0	160.0	152.7	146.2	223.7	216.5	209.7	203.5	223.7	216.5	209.7	203.5	223.7	216.5	209.7	203.6
141.3	148.5	155.3	161.5	197.0	205.0	212.3	218.8	141.3	148.5	155.3	161.5	141.3	148.5	155.3	161.5	141.3	148.5	155.3	161.5
61.3	59.3	57.5	55.7	46.0	43.8	41.8	40.0	61.3	59.3	57.5	55.7	61.3	59.3	57.5	55.7	61.3	59.3	57.5	55.7
106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176	106,176
258,150	268,771	280,800	295,865	258,150	268,771	280,800	295,865	263,649	275,521	288,954	305,715	295,865	295,865	295,865	295,865	341,991	341,991	341,991	341,991
51,358	60,750	70,214	81,739	40,297	48,521	54,906	62,574	53,712	66,822	77,235	89,913	41,786	53,203	66,278	81,739	51,450	61,041	85,333	112,976
156,385	169,848	173,912	176,865	123,563	125,540	126,655	126,945	156,385	169,848	173,912	176,865	149,565	159,217	168,285	176,865	164,552	175,172	185,148	194,588
415,684	435,697	457,190	483,780	404,623	423,468	441,882	464,615	423,537	448,519	472,565	501,804	443,827	455,244	468,319	483,780	419,617	509,208	533,500	561,143
572,069	605,545	631,102	660,645	528,186	549,008	568,537	591,560	579,922	618,367	646,277	678,669	593,392	614,461	636,604	660,645	664,169	684,380	718,648	755,731
623,427	666,295	701,316	742,384	568,483	597,529	623,443	654,134	633,634	685,189	723,512	768,582	635,178	667,664	702,882	742,384	715,619	745,421	803,981	868,707
109,501	105,098	99,269	91,414	82,018	77,243	71,858	65,183	105,965	101,036	94,736	86,471	89,303	84,531	88,238	91,414	75,420	73,685	82,248	84,228
209,351	210,739	211,662	212,568	203,761	204,824	204,575	204,146	208,837	211,626	212,516	213,383	195,013	200,030	205,775	212,568	183,918	193,564	202,798	213,306
288,084	292,891	292,176	290,280	265,985	265,546	263,211	259,925	285,947	291,766	290,759	288,592	260,750	269,988	279,717	290,280	252,469	260,151	273,177	287,274
313,947	322,275	324,683	326,196	286,278	289,015	288,631	287,419	312,431	323,295	325,507	326,826	273,091	293,365	308,855	326,196	272,026	283,355	305,615	330,219
321,749	298,986	269,793	230,790	194,018	169,804	143,936	111,991	305,143	278,398	246,954	206,001	194,457	209,945	222,179	230,790	175,869	192,908	196,105	195,200
242,996	216,834	189,279	153,078	131,802	109,082	85,300	56,212	228,003	198,259	168,711	130,752	128,740	139,587	148,237	153,078	113,318	126,321	125,725	121,232
217,133	187,450	156,772	117,162	111,509	85,613	59,880	28,718	201,519	166,730	133,963	92,558	110,379	116,610	119,115	117,162	93,761	103,117	93,288	78,287
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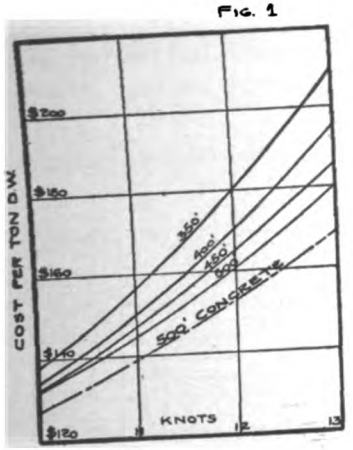
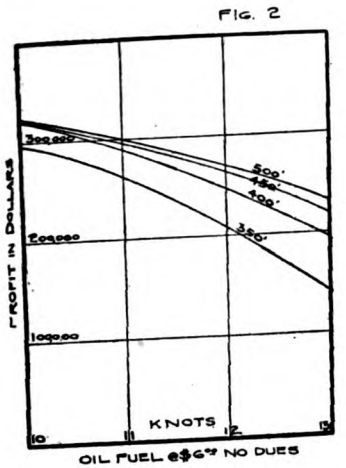
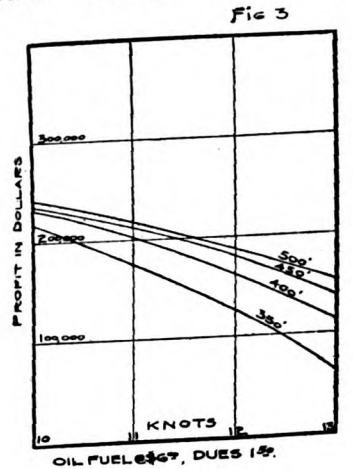
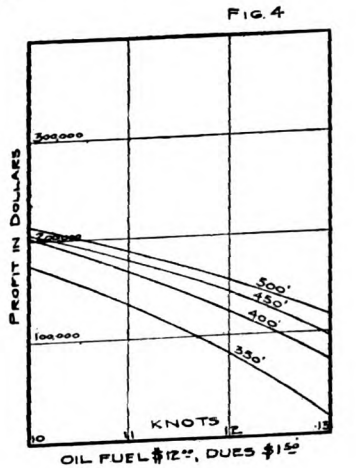
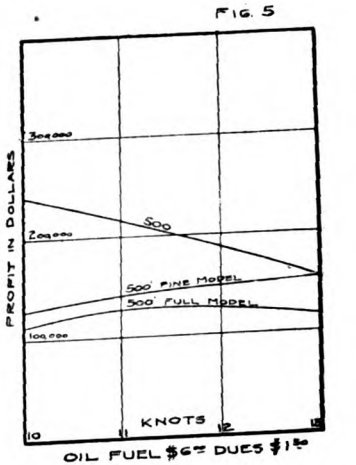
Plate 2.—Results of Calculations

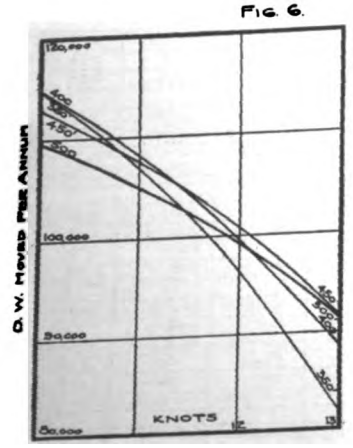


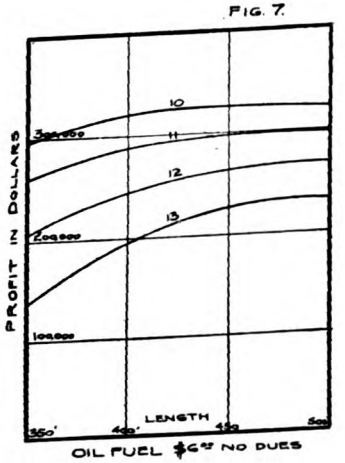


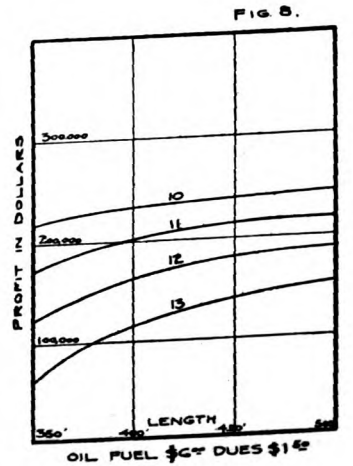


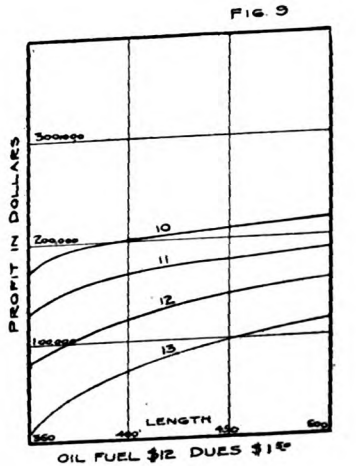


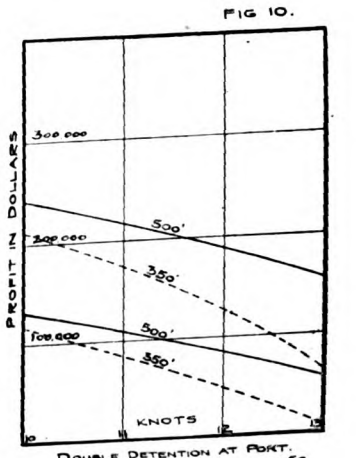












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as could be maintained in any ordinary weather at sea. The power was arrived at in each case from tank test data, a propulsive coefficient of 52 percent being assumed and a margin of power allowed to maintain the required speed at sea. A discount of 20 percent from the figures given for indicated horsepower should be made to arrive at the horsepower on a smooth-water trial trip fully loaded.

(*c*) *Weight of Ship.*—The weight of the steel hull has been found to vary slightly with the block coefficient, and this variation has been allowed for. The weight of outfit corresponds to a first class specification and has been taken as identical for each length of vessel, irrespective of speed. The engine room weights are taken as varying directly with the horsepower, taking 4 horsepower to each ton of engine room machinery. The total deadweight was assumed to be the difference between displacement and the sum of steel hull, outfit, and engine room weights.

(*d*) *Cost of Ships.*—The cost of the steel hull was assumed to vary directly with the weight of steel used, and the cost of outfit was taken as constant for each size of ship. The cost of propelling machinery is based directly upon the horespower developed; and the basis of these costs was so chosen that the 400-foot ship, at 11 knots speed, would show a cost of approximately $150.00 per deadweight ton.

(*e*) *Weight of Fuel and Stores.*—The fuel oil consumed was figured at one pound per indicated horsepower per hour, plus a fixed amount for each size of vessel in port. The port fuel consumption allowed for minimum detention was taken as 20 tons for the 350-foot ship, 30 tons for the 400-foot ship, 40 tons for the 450-foot ship and 50 tons for the 500-foot ship. A figure was taken for fresh water, make-up feed, and consumable stores equal to one-half the weight of the fuel oil required per voyage.

In fixing a fuel rate per ton of oil fuel it is intended that this figure should cover also the cost of lubricating oil, fresh water and similar charges based on the horsepower of the engine. For this reason $6.00 and $12.00 as fuel rates would represent a cost somewhat lower than this for the oil alone.

(*f*) *Port Detention.*—The time in port is of great importance in the estimated cost of operation of a ship. This is a variable figure, and calculations are given showing the effect with minimum detention and with a detention equal to twice the minimum. I have taken a figure for the minimum length of time in which a vessel should be detained in port as depending on the quantity of cargo which must pass through every square foot of hatch. This quantity, of course, with similarly designed ships, depends directly upon the depth of the ship, and I have therefore allowed one day in port for every 5 feet in depth of ship, as a minimum port detention figure. In addition to the above port detention, thirty days per annum have been allowed for overhaul.

(*g*) *Operating Expenses.*—The cost of crew is estimated from the United States Shipping Board's rate current at the beginning of this year and includes an allowance of $300.00 per annum per man for sustenance. In addition, a management allowance has been made of $500.00 per month. The cost of manning, however, must be considered as only approximate, as the exact number of crew would depend to a certain extent on design of ship and route.

Depreciation, insurance and up-keep have been figured at 13 percent per annum on the first cost of the vessel. Tonnage dues have been assumed at $1.50 per net ton register, and the assumption has been made, for the sake of comparison, that the net tonnage in each ship would be equal to one-third of the load displacement in tons.

After figuring out the cost of the ship, its deadweight carrying capacity in tons of 2,240 pounds, and cost of operation per annum, these figures have been reduced in each case to the basis of $1,000,000 investment; and in order to make the figures more easily grasped I have assumed a gross freight rate of $6.00 per deadweight ton for the 3,500 nautical mile run. From this rate, however, I have deducted $1.00 per ton for handling and 15 cents per ton brokerage, showing a net revenue of $4.85 per deadweight ton on this run. For the 7,000-mile run I have assumed the freight rate of $10.00 with a deduction of $1.00 per ton for handling and 25 cents per ton for brokerage, giving a net rate of $8.75.

The profits in operation calculated on the above assumptions have in each case been figured upon the assumption that the ships are operated on each leg of their route with a full cargo. This assumption is only a hypothetical one. The freight rate should therefore be so adjusted that it shall bear the proportion to the assumed rate that a full cargo does to the average percentage of cargo carried per trip. For example, if the ship operated with an 80 percent load in one direction and a 20 percent load on the return voyage, 100 percent load is divided between the two voyages, so that only 50 percent freight movement is achieved and the freight rate would therefore be doubled to realize the profits shown on the table, Plate 1.

RESULTS

The results of the calculations are shown in a series of diagrams on Plates 2 and 3 and may be readily summarized as follows:

(*a*) *The Cost Per Deadweight Ton.*—Fig. 1, Plate 2, shows this to be extremely sensitive to speed, increasing rapidly in all sizes of ship with increase of speed. Fig. 11, Plate 3, shows that the cost is only slightly sensitive to increase in size, showing tendency to fall with increase up to about 450 feet at 10 knots and a larger size for faster vessels.

(*b*) *Deadweight Moved Per Million Dollar Investment Per Annum.*—Fig. 6, Plate 2, shows clearly that for large freight movement slow speed is essential. At 10 knots a 350-foot ship will move more cargo than any larger vessel. At 11 knots the 400-foot ship is the best; at 12 knots the 450-foot ship is better, and at 13 knots the 500-foot ship will move as much as any smaller size.

(*c*) *Profits Earned Per Million Dollar Investment.*—Figs. 2, 3 and 4, Plate 2, show the profits earned for a 3,500-knot run as plotted upon speed of ship, and Figs. 12, 13 and 14, Plate 3, are corresponding diagrams for the 7,000-knot run. Figs. 5, 6 and 7, Plate 2, show results for the 3,500-knot run plotted on the size of ship.

All these diagrams show clearly that the slow-speed ship is the money-earning ship, and there is a very steady decline as the speed increases; the 350-foot ship earning twice as much at 10 knots as at 13 knots.

It will be noted from Figs. 7, 8 and 9, Plate 2, that at a speed of 10 knots, a ship 400 feet long gives practically the very best earning proposition that can be designed, and that for 11 knots a length of 450 feet is probably the maximum economical length. These figures, of course, assume the ship to have a capacity cargo, and even a small reduction in this cargo would tell heavily against the larger ships.

These curves completely justify the building of tramp ships between 350 feet and 400 feet in length, with a sea speed of 10 knots.

(*d*) *Form of Ship.*—To compare the effect of a single design run at various speeds, with designs worked up for the individual speeds, calculations were made which are plotted on Fig. 5, Plate 2. The figures for these calculations are shown in columns 32 to 39, Plate 1.

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Plate 3.—Reuslts of Calculations

FIG 11.

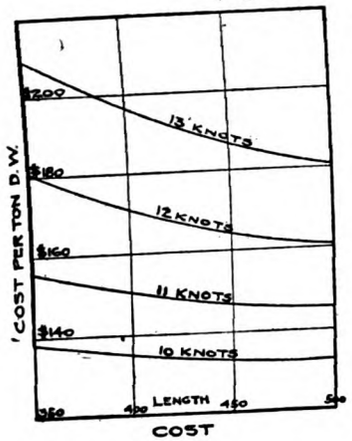


FIG 12.

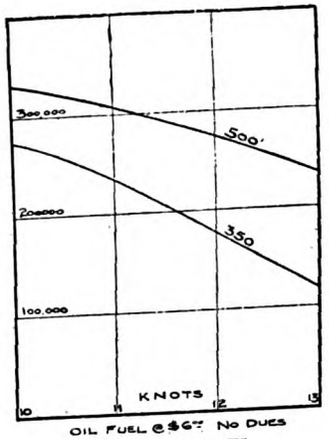


FIG 13.

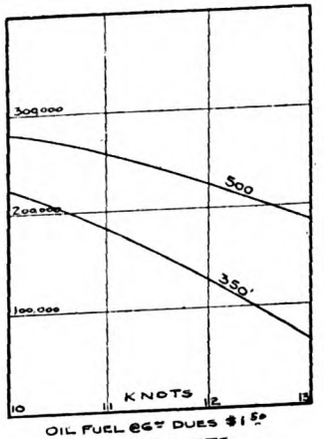


FIG. 14.

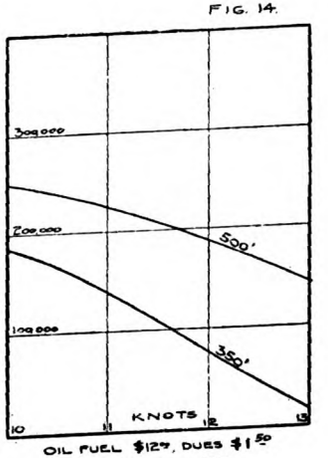


FIG 15.

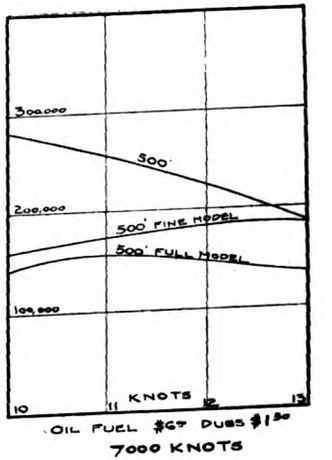


FIG. 16

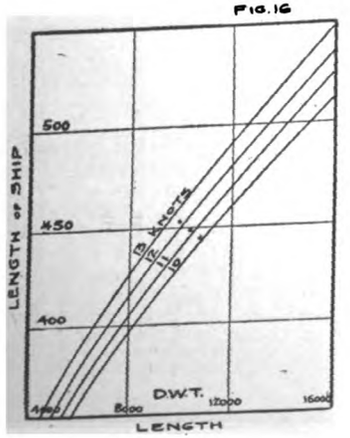


FIG. 17

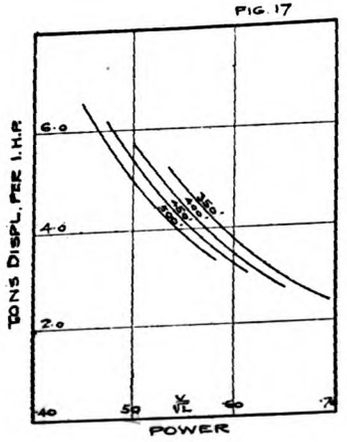


FIG. 18

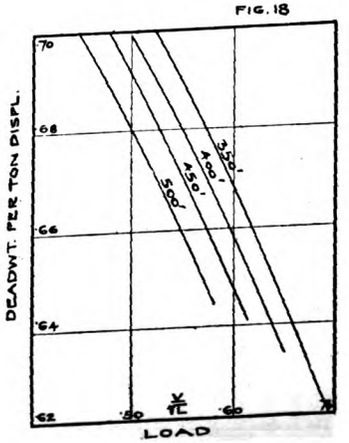


FIG. 19

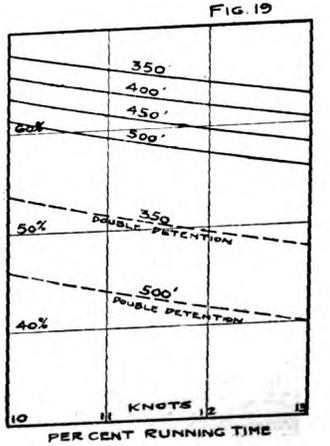
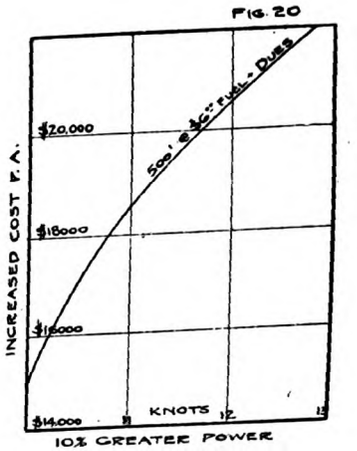


FIG. 20



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They show that a vessel designed for a speed of 13 knots, and powered for that speed, will earn more for her owner running up to full speed than at a lower running rate. On the other hand, a vessel designed for 10 knots, with power good for a speed of 13 knots, shows a falling off in earning at speeds over about 11 knots. This diagram clearly shows the advantage of having a ship carefully designed to work under specific conditions.

(*e*) *Value of Model Experiments.*—Fig. 20, Plate 3, shows the actual loss in profit for the 500-foot ship where the power to drive it is 10 percent above the minimum. This 10 percent seems large, but I assure you it is a very modest estimate of the increase of power necessary in a model designed without the use of experimental data. Even careful students of ship resistance might produce a ship design of this kind. This year, for example, we were able to lower the resistance of a 400-foot ship at 10 knots by 8 percent through increasing the displacement by 1½ percent; and in another case, with two ships of identical size and fullness, a slight change in the curve of areas of afterbody made 6½ percent difference in resistance without change of displacement.

The cost to the shipowner of this extra 10 percent is one of the astonishing features of the figures compiled.

At 10 knots the extra power for the 500-foot ship is 325 horsepower, and this gives an actual loss in earning capacity of $16,636.00 per annum, which, at 5 percent compound interest, represents in twenty-five years 79 percent of the cost of the ship, or, in this particular case, $1,610,250.00. At 13 knots the cost is even greater; the 583 additional horsepower costing the ship operator a loss in profit of $24,789.00 per annum, equal to $2,782,230 for the 500-foot 13-knot ship in a life of twenty-five years.

(*f*) *Detention in Port.*—Fig. 10, Plate 2, shows for the 500-foot and 350-foot ships the difference in realized profits if these ships are detained twice as long in port as the ship with which they are compared. Every shipowner is aware that the earning capacity of the ship is measured by its time at sea, but these figures will help to emphasize the necessity for greater care being given to the improvement of the methods of loading and unloading ships.

In Fig. 19, Plate 3, the time at sea is expressed as a percentage of the year, and it is shown that the slow-speed ship can remain at sea for a higher percentage of its life, and to this largely is accountable the superior earning capacity of this type of ship.

(*g*) *Application to Design.*—Figs. 16, 17 and 18, Plate 3, give, respectively, size of ship, power of ship, and capacity of ship for the various speeds and sizes dealt with in this paper. These three diagrams should be of some use for preliminary design work to rapidly approximating the dimensions of a new ship. They are only of definite value, of course, if the proportions and characteristics of the ships are similar to those dealt with in this paper.

(*h*) *Fuel.*—Figures compiled for the 500-foot ship indicate that for the same profits the cost of coal fuel could only be 53 percent of the cost of oil fuel. This figure, of course, includes putting coal in bunkers, and it takes full consideration of the saving in weight and increase in carrying capacity of the ship, due to the use of oil fuel. This economy in oil fuel will not be maintained, of course, if the ships are not running with capacity cargoes.

(*i*) *Concrete Ships.*—The 500-foot ship was calculated also as a concrete ship, and the assumption was made, for the sake of comparison, that depreciation, insurance and up-keep would be at the same rate per annum as the steel ship, viz., 13 percent. On this basis, in order that the concrete ship should show the same operating profits with the steel ship (the cost of machinery being the same), the cost of hull and outfit for the concrete ship at 10 knots should not exceed 79 percent of the cost of the hull and outfit of the steel ship, and at 13 knots it should be limited to 70 percent of the cost of the steel hull and outfit. The cost of a concrete ship per ton of deadweight to show equal profits with the 500-foot steel ship, is shown on Fig. 1, Plate 2.

These figures are on the basis of $6.00 fuel and no dues, but they are approximately true for the other working assumptions.

American Bureau of Shipping Approves Thermit Welding for Marine Repairs

AN important development of thermit welding in American shipyards is anticipated by the recent approval by the American Bureau of Shipping of the thermit process for welding stern frames, rudder frames, and other heavy sections on ships registered under their classification. The only qualification is that this Bureau be notified sufficiently in advance to have a surveyor in attendance during the welding operation as well as to inspect and test the weld when completed.

While the thermit process has been used since 1903 for making marine repairs and has a great many successful welds of this nature to its credit, the process was never officially approved by the American Bureau of Shipping and most of the repairs were made on vessels not classed by them. It is due entirely to the unbroken record of successful marine welds that the Bureau now accords its official sanction to the process. According to a statement by the Metal & Thermit Corporation there has never been a single failure of a thermit marine weld so far as it has been able to ascertain in all the years that the process has been used under this company's jurisdiction.

Now that the United States promises to have one of the largest merchant marines in the world, and as practically all of the ships which have recently been constructed, and which will be constructed in the future, will be registered with the American Bureau of Shipping, the recognition of the thermit process by that Bureau bids fair to result in many important thermit marine welds from now on.

New Fitting-Out Wharf at Fore River

THE march of progress throughout the entire Fore River plant of the Bethlehem Shipbuilding Corporation at Quincy, Mass., has touched the water front and now the fitting-out dock built 18 years ago is being reconstructed. When the present dock was built in 1901 it was thought that the construction of concrete upon piling was strong enough to last a lifetime. The advent of heavier machinery proved this to be a fallacy and the constant strain of the enormous crane used in outfitting the ships has made it necessary to rebuild 180 feet of the dock.

When the firm of Holbrook, Cabot and Rollins, of New York and Boston, started the work of construction, it became necessary to use dynamite to break up the concrete that had been under water many years. The new wall will be built of granite blocks which will be placed in position when lowered to divers. The wall will be 180 feet long, 30 feet wide at the base and will taper toward the surface. The new dock will give berthing space for the largest vessels built at the plant as the water alongside will be dredged to a depth of 35 feet below low tide. It is expected that the dock will be finished by February, 1920.

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Suggestions for the Profitable Operation of the American Merchant Marine

BY COMMANDER H. C. DINGER, U. S. N.

Basing his remarks upon close observation of the status of the United States merchant marine in world ports, Commander Dinger in this article offers constructive criticism on possible means for bringing about more profitable ship operations. He perhaps touches the crux of the problem when he bares our lack of co-ordinated national action in the shipping field. As a naval officer he recognizes the necessity of building up an organization composed of well-co-ordinated, functioning units which will operate under a supervising agency.—THE EDITOR.

THE United States has, through the circumstances of the War, suddenly acquired a large amount of shipping and is building a still larger amount. The shipbuilding and ship operating business from being a weak outcast has suddenly come into prominence. Shipping is vital to the industrial success of the United States in the markets of the world, as important to the country as communication is to business. Is the position of the United States in this field to be maintained?

By properly co-ordinating the elements concerned in shipping, by securing the highest industrial efficiency in all the activities relating to it, by providing the fostering care which the United States Government can and should give, and above all by securing the active support of public opinion, this vital industry can be so well established that it will become a mainstay to the resources of the country.

> We must produce more tonnage at a cheaper rate per ton. Unless employers and workers co-operate in accomplishing this, the industry will perish. If labor and capital will work together we can compete with the world.—*J. H. Rosseter, Director of the Division of Operations of the Shipping Board.*

To make a success of shipping, the Government must assist the industry, perform certain services which will facilitate its business, encourage its activities and remove such difficulties as may come within the sphere of governmental action. Handicaps and restrictions in the shape of bad laws or unjust imposts must be removed and particular advantages possessed by foreign competitors be compensated for in a proper and reasonable manner.

On the other hand, the private shipping industry must be built up on efficient and systematic lines so that it can operate economically and render adequate service to the industry of the nation.

As the shipping industry has grown up in the United States, the following organizations are the only American agents which are concerned in any public capacity with shipbuilding and ship operation.

(1) The American Bureau of Shipping.—This privately operated organization, like the British Lloyds, is substantially supported and directed by a mutual co-operative arrangement of American shipbuilders. It defines the rules of classification upon which marine insurance is given, makes the surveys and inspections which are the basis for this classification and in an advisory capacity examines and criticizes plans and specifications of ships about to be built to pass upon their availability for insurance. The British Lloyds performs a similar service. Both agencies promulgate safety rules applicable to the handling of ships and the control of personnel.

(2) The Steamboat Inspection Service.—This organization, which operates under the Department of Commerce, carries out inspections for the enforcement of safety rules for ships and their personnel. In addition, this department formulates rules for personnel on the vessels.

(3) The Bureau of Navigation.—This division of the Department of Commerce compiles records relating to shipping, shipping personnel and cargoes in a form which is useful to governmental agencies and to the shipping industry. In a passive way, that of historian chiefly, the bureau exercises general direction over shipping activities as these are related to development in other countries and to general trade conditions.

From this brief statement it will be evident that up to the time when the United States Shipping Board was esablished this country lacked organization mechanism, either public or private, which was empowered aggressively to boost shipbuilding or ship operation, or aid in the efficient development of the rudimentary tools at hand. A lack of co-ordination of the existing modus operandi further hampered progress.

Any constructive supervision over the shipping field should have included, for example:

(a) Investigation of the laws, rules and procedure affecting property and property rights of vessels, cargoes, freights, charts, etc., in American and foreign countries followed by the publishing of this information in condensed form for shippers and the formulation of amendments or new laws to be recommended for enforcement in those districts under the United States Government jurisdiction.

(b) General direction over shipping activities to aid and control in the development of this field in foreign countries and at home in connection with other trade conditions.

(c) Co-ordination of shipping activities with problems of national defense.

(d) Development of the most improved methods of construction and operation.

(e) Standardization of marine operating and administrative practice to secure savings in cost and operation and for simplifying operation and increasing capacity.

(f) General technical research and experiment for improvement of material. (In a way this research would serve as a basis for the development of the work considered in item d.)

(g) Distrtibution of (1) technical and (2) trade information which would be available as the result of active research work.

(h) Standardization of marine apparatus and equipment to improve production.

The Shipping Board is now functioning in many of these once untouched fields.

Through the Shipping Board and the Emergency Fleet Corporation—emergency agencies—the government has

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been able to construct ships and undertake the establishment of United States steamship lines in places and under conditions where private capital would have hesitated to take the risks.

These organizations, however, are only the pioneers of a modern United States merchant marine. A government owned shipping company can never be the full answer to the shipping problem. The real merchant marine that is needed will be produced and developed by the initiative of private industry, properly assisted and directed by the Federal government in those fields where it can be particularly helpful.

BUREAU OF MARITIME COMMERCE

To this end, the logical thing would appear to be to convert the Bureau of Navigation into a Bureau of Maritime Commerce, which should be as ambitious in its development as the Department of Agriculture or the Bureau of Mines. It would be the duty of this organization to give advice, information and, to a certain extent, assume supervision over shipping. This Bureau of Maritime Commerce should make a thorough examination of all laws affecting ship operation and recommend changes and additions which would place American ships on the seas without handicap. Should the Shipping Board be discontinued at the end of the "war emergency," this country would lack any organization which could act as a co-ordinating agency. In this case the Bureau of Maritime Commerce would have to assume active direction over shipping activities.

The Bureau of Navigation as now organized is not able to make technical researches or to take any part in initiating action which would bring about development or improvement of the shipping industry. The Steamboat Inspection Service, while responsible for the formulation of government safety rules regarding personnel and equipment, does not touch upon any phase of the development of the shipping trade. It would seem advisable, therefore, to have this service supplied by the privately operated American Bureau of Shipping in conjunction with technical engineering societies and technical bureaus of the Navy Department under the supervision of the Department of Commerce.

Right here we would suggest the possibility of co-ordinating the inspection service of the American Bureau of Shipping and the Steamboat Inspection Service. Some functions of the two organizations are similar. The requirements for insurance are more elaborate, however, than those for the safety rules; they are also more flexible, accommodating themselves more quickly to changes in technical practice. If, therefore, the American Bureau of Shipping were employed, on those vessels which they are inspecting for insurance, to make whatever additional inspection would be necessary to cover the safety rule requirements, the need for a complete duplication of these two inspection services would be obviated. This is a perfectly feasible project. The Navy Department for example, has employed the New York Chamber of Commerce fuel inspection service for a number of years with entire satisfaction and at an extremely reasonable cost.

But to return, the American Bureau of Shipping should be evolving standard specifications for ship and engine building practice, ship repair work, and for ship operation. Such investigation would serve as a basis upon which improvement could be effected in technical lines. If this agent were authorized by the Government to do technical research work in naval architecture and marine engineering, it could enlarge its technical department and by working with all other agencies engaged in similar work could serve as a centralizing medium in an organized, systematic effort to accomplish these ends.

It may not be amiss to mention some of the marine engineering problems about which the technical department of the American Bureau of Shipping could carry on investigations:

(1) The adjustment of commercial marine practice to the best foreign practice and to the requirements of naval practice for such vessels as may be used for naval purposes in case of war.

(2) Definition of good practice in construction and design based on naval practice, the requirements of Lloyds, British Board of Trade, Steamboat Inspection, etc., as a guide to shipbuilders and ship operators.

(3) Development of standard methods of construction, operation and marine engineering practice.

(4) Preparation and standardization of general specifications for hulls, machinery and for materials and devices entering into shipbuilding.

(5) The standardization of the shapes, dimensions, form and interchangeability of the following ship parts:

Hull fittings, shapes and plates; doors, ladders, hatches and coverings; anchors and anchor gear; boats and their hoisting gear; booms, masts and hoisting gear; riveting, framing and fastenings; boilers and boiler tubes; grates, furnaces and boiler fittings; oil fuel burning equipment; piping systems and pipe lengths; pipe fittings, flanges and valves; condenser tube sizes, gages and lengths; pumps and auxiliary machinery; electric wiring and wiring systems; instruments used on vessels; bolts, nuts, rivets, screws and other engineering fastenings.

A most valuable service would be the publication of a list of materials and devices that had been examined, tested and found satisfactory for marine service, indicating the particular uses for which they would be most suitable. This might obviate the use of unsuitable material and devices and thus secure better and more efficient ships and machinery.

(6) Determination of devices and processes of manufacture thought to be desirable for development and experimentation. Lists of such devices might be published from time to time.

(7) Research in such matters as improvement in quality of materials, preventatives of corrosion, causes of failures in materials such as crank shafts, boiler tubes, condenser tubes, cylinders of oil engines, etc.

FACTORS OF ECONOMICAL SHIP OPERATION

But to turn specifically to the question of economical ship operation, the following points demand consideration:

(a) The first cost of ships.

(b) Operating conditions, including the routing of ships and provision for adequate cargo facilities.

(c) Marine insurance.

(d) Cost of operating vessels.

As the shipping business is now handled, cargoes are secured for ships and ships for cargoes through ships' brokers. As a rule no one broker controls enough cargo space to really give first class service to the shipper. A large ship brokerage organization with well established agencies and with a large tonnage at its disposal could bring about an immense reduction in the cost of handling miscellaneous cargoes and could also increase the cargo-miles of the ships under its jurisdiction. By establishing a United States overseas ship brokerage association under the regulation of the United States Government and assigning to it all Shipping Board vessels and any private vessels which might desire to avail themselves of the service one great step would be taken in securing better economy in operating our merchant marine.

To provide proper terminal facilities in foreign ports where our vessels are to trade, a large corporation should be organized to be operated under government supervision and regulation. This company should erect terminal facilities in foreign ports where such facilities would be required for our shipping. Such a corporation might be organized in connection with the Shipping Board. Just as the Emergency Fleet Corporation has been provided to build ships, the Port Corporation could be organized to build and operate terminal facilities.—COMMANDER H. C. DINGER, U. S. N.

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(e) General business conditions, laws and practices governing operation of shipping.

The cost per ship must be brought down to a figure which compares favorably with the cost for a ship with equal equipment in foreign lands. Already a large portion of the shipbuilding materials can be made in the United States as cheaply as elsewhere. The amount of material needed and the cost of its fabrication can be reduced very materially by efficient standardization, not so much of the ships themselves, but of the parts and equipment which go into the ship.

If we learn to build ships in quantity, as we do automobiles or agricultural machinery, for instance, we can build good serviceable ships much more cheaply than we have been building them. Moreover, to use a developed standard design, well tried out, will be better than to design anew each time. Then, to lower the price, we must build on a large scale, put shipbuilding on a manufacturing basis. This is where an immense plant like Hog Island will eventually prove its advantage. Though perhaps the first cost of this plant may be enormous, and its building may have been wasteful, when once it gets its stride and is well organized and outfitted with competent workmen, it will be able to build vessels very cheaply in spite of the high initial cost of the plant.

The rules of the classification society under which the building is done may materially add to or lower the cost. In this field the American classification societies can give valuable assistance in arranging their rules to permit and to encourage economical production, while continuing to provide for safety.

The labor charge at the shipyard and engine plant represents nearly fifty percent of the cost of a vessel. This can be reduced, of course, by using labor saving devices and by standardization of parts and of methods. But a still more potent factor lies in the skill and capacity of the workmen. This is largely a matter of training and of keeping workmen at a particular line of work to make them expert. The excessive labor turnover in the United States machine shops and shipbuilding yards results in a serious loss to all concerned and makes the ships cost more. The War Labor Board has brought about a rise in wages, but it has not added to labor's efficiency. Labor should be paid in proportion to the skill required and the output produced. Any other basis is illogical and likely to be extravagant. If poor, indifferent and careless workmen are to receive the same compensation as those who produce excellent results, efficiency will surely suffer. At present, the highly skilled and reliable worker receives too little, while the unskilled, lazy and indifferent man receives too much. If labor costs of shipbuilding are not put upon a basis where the United States can compete with the foreign shipbuilder, the excess cost will have to be made up by the public in some other way or we will cease to build ships except for local service.

General Operating Conditions—Need of Cooperation

Much of the handicap which makes the operating cost of United States vessels high can be made up by more efficient routing and despatching of vessels and more intelligent preparation of cargoes so that the stay of vessels in port, awaiting loading and unloading, is lessened and the cargo-miles per year increased. A study of the cargo to be moved, its location, and the ships available would enable the routing to be made much more intelligently. Some governmental agency such as the Department of Commerce or the Shipping Board could do yeoman work along these lines which would greatly add to the efficiency of the United States vessels, so that the maximum of freight might be moved with the minimum of ships. It is inefficient to operate competing lines in fields where one line can more than handle the actual business. On the other hand, if in certain regions there is a deficiency of freight, a study of the whole situation should be made to see if additional cargo can not be made available. Such a general study can be made by a governmental agency, supplemented by the various shipowning companies and associations. It will, of course, be advantageous to have the ship operating organizations control a considerable number of vessels. For this reason large shipping companies should be encouraged or combinations formed of several small companies for the purpose of routing and assigning cargoes. In any case there should be the very greatest cooperation between American ship operating companies; all competition should be with foreigners rather than with American ship operators.

If this line of endeavor is consistently carried out by the Federal government, by the public and by the shipowners and shippers, it will be possible for United States shipping to do our carrying trade as cheaply or more cheaply than the foreigner can. But, if these different activities become antagonistic to each other and work against each other, the foreign shipowner will profit.

Since it costs nearly as much to keep a cargo vessel in port as it does to have her moving at sea, the advantage of reducing this stay in port to the irreducible minimum may be appreciated. Terminal facilities are the controlling factor here. This applies particularly to loading facilities, but unloading facilities for special bulk cargo are equally important.

The problem should be considered from a national standpoint. Each port should be made adequate for the freight and cargo that should be allotted to it in the general scheme. If this is done, we will have the most efficient facilities at the least cost to the whole country which will mean the lowest practical carrying charges. Antagonistic competition between ports profits the foreigner only. An increase in our foreign trade will make more work for all of the ports, each receiving profits in proportion to the service it renders in the general scheme.

The responsibility for providing and regulating port facilities should be under state jurisdiction, in some cases under municipal jurisdiction. Private enterprise cannot develop a large harbor in any systematic manner. The general planning and a large part of the actual building of wharves, storage houses and handling facilities should be carried out by the state and subsequently made available for public use at a price which will cover the cost of service.

To provide proper terminal facilities in foreign ports where our vessels are to trade, a large corporation should be organized to be operated under government supervision and regulation. This company should erect terminal facilities in foreign ports where such facilities would be required for our shipping. In certain ports, such an agency might not be allowed to build and operate, but in many other locations where facilities are badly needed, authority could no doubt be obtained. Such a corporation might be organized in connection with the Shipping Board. Just as the Emergency Fleet Corporation has been provided to build ships, the Port Corporation could be organized to build and operate terminal facilities.

With terminals comes the question of proper storage facilities at ports to prevent loss and damage to perishable cargo; also the question of providing bonded warehouses or free ports. The Panama Canal Zone, St. Thomas, Key West, Honolulu, and other places might be made

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free ports to attract shipping business for interchange of cargo.

MARINE INSURANCE

The subject of marine insurance is, of course, a field in itself. Practically all marine insurance up to the beginning of the late war was handled by foreign companies, mainly British and German.* United States shipping was paying toll to foreign enterprise. We certainly should insure our own ships and, under government supervision, this could be handled at lower rates. If we operate our own insurance, we can make the rules as favorable as possible to United States vessels and industries, thus reducing the actual expense of the insurance.

The American Bureau of Shipping under government supervision and backing offers a convenient method of providing for American marine insurance classification. As a semi-commercial institution the shipowning and shipbuilding representatives can keep its methods up to date and see that the insurance requirements are such as to give the best service to the trade in general.

REDUCING THE COST OF OPERATION OF SHIPS

In considering the cost of operating vessels per cargo mile the main factors are (1) efficiency and reliability of officers and crews, (2) consumption of fuel and supplies and their cost, (3) economy, state of repair and material upkeep of vessels, and (4) speed with which reliable repairs, docking and overhauling can be accomplished.

> The United States cannot hold its own in competition with other nations unless additional facilities are created abroad by private enterprise, especially by the shipping companies. Little has been done in this direction as yet because of uncertainty on the attitude of the Government.—*J. H. Rosseter, Director of the Division of Operations of the Shipping Board.*

Practical requirements should be made the basis for the licensing of officers and manning of vessels. An efficient system for training and developing officers and men for the merchant service is also of the greatest importance. In these lines the Federal government can greatly assist. Methods of scientific management and welfare must be applied to the personnel operating the vessels. Efficient bonus or profit sharing systems will reduce the actual cost of operating ships. Such systems are now employed to a considerable extent on fishing vessels, but have not yet been applied to freight and passenger carrying vessels. Obligatory pension systems and sickness and disability benefits will add much to the efficiency of the personnel and enable the shipping business to secure more intelligent and hence more efficient labor.

Each ship operating company should know the supplies needed for its ships, and the products which are most suitable to fill these needs. A general purchasing agent should purchase these supplies in large quantities. Ships might be placed on a money allowance, as is now the custom in the Navy. Competitions between different vessels for performance and economy in operation, with bonuses for saving, would, no doubt, improve results, saving money to the company as well as providing more remuneration to the crews and indirectly lowering rates. The cost of fuel is largely a matter of where it is purchased; its economical use is dependent upon the efficiency of the machinery and of the operating force. The intelligence and capability of the operating force is the vital factor, since it may easily double the amount used. As this cost may easily be several times the amount of the men's wages, it may be an advantage to pay high wages if thereby fuel is saved.

A careful supervision over the use of material and the establishment of proper standards or allowances, together with thorough investigation and accountability for all cases of waste will reduce the expenditure for supplies to a proper basis.

ECONOMY AND STATE OF REPAIR AND UPKEEP

If a vessel is kept in perfect condition by its crew it can be operated more economically and will also require fewer repairs, and, what is very important, will require less time in being laid up for repairs. To secure satisfactory conditions, efficient supervision and inspection of all vessels is required. Information as to the best methods of operation and maintenance must be distributed among the crews and put into practice. This will not be done if each vessel is permitted to work out its own salvation. By having a scientific, technical staff, however, to supervise and direct and to co-ordinate the personnel of the different ships that may belong to any one organization, excellent results may be obtained. Each shipping company should systematize the training and instruction that is given to the operating personnel and see that good practice is uniformly carried out.

SPEED AND ECONOMY IN MAKING REPAIRS

If the ship's force is encouraged to make its own repairs and is given the facilities for doing this, much shop and dock yard work may be avoided. An extra mechanic or two and a few machine tools placed on board the ship will more than save their cost. A periodic overhaul after careful inspection by the supervising engineer will also reduce the final repair bill and guarantee reliable operation. Repairs at small and inadequate shops in remote foreign ports and in places where facilities are lacking are very expensive, hence care should be exercised that this work is done at home ports, in well equipped shops where repairs can be adequately accomplished. Previous to the war, foreign vessels did not have repair work done in the United States if they could possibly avoid it on account of inadequate facilities and high costs then current. The recent development of American repair facilities has eliminated this cause of complaint against American ports.

OTHER CONDITIONS WHICH RELATE TO THE SHIP OPERATING FIELD

Petty graft adds materially to the cost of operating vessels. As commonly practiced, the masters and engineers get a 10 or 20 percent commission on charges made to the ship for stores, fuel, repairs, tug hire, etc. This is a common practice, but a thoroughly vicious and indefensible one. The only excuse for it, a poor one, is that the wages paid are so low that the graft fees are a justifiable increase to the pay of the captain and chief engineer. The pay received by ships' officers should, of course, be adequate. A bonus system for saving and efficient operation is the remedy, but the gleanings should go down to the subordinate officers and crew as well. We have long since abolished prize money in the Navy and it is time that the commission graft in the United States merchant marine be consigned to limbo.

Again, there are too many middle men in the management of sea going freights and the control of the ship's expenses. These middle men toil not, neither do they spin, but they reap what should go toward lowering freight rates and providing better wages and living conditions for the crews of the vessels.

*EDITOR'S NOTE:—See summary of present insurance conditions contained in article appearing in this issue.

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Seafaring labor must be brought into proper co-operation with the shipping industry. In various places there has not been present a proper co-operation between the more radical element among the labor leaders and the shipowners. Where the labor leaders have demanded impractical, wasteful and expensive conditions, which, while adding greatly to the expense of operating ships, did not improve the ships, the living conditions of the operators, or the efficiency and economy with which ships can be operated, they have been a handicap. Where they have aimed to conserve the just rights of the worker and secure fair treatment and proper living conditions, they have helped. Restrictions which limit production so that an operator is not allowed to repair his own machinery or work more than eight hours a day, no matter what the emergency, and demands for entirely unnecessary personnel cannot be defended and merely give the foreign ship an advantage. On the other hand, the shipping industry must realize that the day of the shipping agent and the bucko-mate are past. The seafaring workers have rights and even some privileges and improved conditions and treatment will naturally produce more efficient and more loyal crews.

The Part of Labor in Economical Operation

If the organizers of seafaring labor will advocate efficiency and economy, they can do a very great service. When such an attitude is assumed, it is likely that shipowners will meet them half way by improving conditions so that a high standard of living and of efficiency may be maintained on United States merchant vessels. The present differences between the leaders of seafaring labor unions and shipping operators are a serious handicap to the efficiency of the United States merchant marine. These must be overcome before the United States can successfully meet foreign competition. Our ships are a national matter, in which our industry and the general public are deeply interested and concerned, consequently when the real facts are known, needed relief from the attempted restrictions of the more radical labor leaders may be secured.

Centralizing Ship Brokerage

As the shipping business is now handled, cargoes are secured for ships and ships for cargoes through ships' brokers. As a general rule there are altogether too many brokers, consequently no one broker controls enough cargo space to really give first class service to the shipper. We need a large ship broker organization with agencies in all the principal ports. This organization should have under its jurisdiction the cargo space of practically all of the United States shipping offered for service. The present system is as if 500 separate telegraph and postal companies were operating in the United States and every time a business man wished to send a telegram he would first have to go around and find which one of the companies could handle it. The small shipper loses out and has to hire a broker who often charges exorbitantly for his services. A large ship brokerage organization with well established agencies and with a large tonnage at its disposal could bring about an immense reduction in the cost of handling miscellaneous cargoes and could also increase the cargo miles of the ships under its jurisdiction. By establishing a United States overseas ship brokerage association under the regulation of the United States Government and assigning to it all Shipping Board vessels and any private vessels that might desire to avail themselves of the service one great step would be taken in securing better economy in operating our merchant marine.

Under this arrangement anyone having freight to handle would apply to the agency, just as one now does to the railway express. Any vessel having available cargo space would also apply; thus the shipper and the ship would be brought together at little expense to either and the freight would be handled more cheaply, while the vessel would be earning more because its cargo-miles would be increased.

There are now several large forwarding companies, such as W. R. Grace & Company or Gaston, Williams and Wigmore, who serve the shipper in this way. But none of these agents controls enough cargo space to give efficient general service to the small shipper who desires to ship to various foreign ports. In other wards, we must provide offices centrally controlled for our United States world delivery system. In foreign ports it is important that we have a United States office to handle that end of the delivery as well. At present our shipping business is handled largely by foreigners both in foreign ports and in the ports of the United States.

Removal of Legal Restrictions on Trade

I need not mention that the LaFollette seamen's act and certain navigation laws greatly hamper the development of the United States merchant marine. The so-called Webb law has been designed to correct defects in certain anti-trust laws as these relate to foreign trade activities. Steps should also be taken to have the LaFollette law modified along national, sensible and patriotic lines. Our navigation laws, though they have been changed for the better during the war, need further revision.

There should be provided some recognized impartial and expert authority in the Department of Commerce to whom all proposed laws effecting the shipping industry could be referred for comment and recommendation before they are acted upon by Congress. If this were done the shipping industry would have some properly appointed and authoritative champion who could be on the lookout for its interests.

Finally, when we have adjusted shipbuilding and ship operation upon an efficient and scientific basis, we may find that due to special conditions (mainly much lower labor costs) the foreigner can still operate his vessels more cheaply than we can. This condition would indicate the need of some further public assistance to the shipping industry—the giving of preferential duties to imports in United States bottoms and the fixing of lower port charges for vessels flying the United States flag. This is, of course, an indirect subsidy, but it is fully justified. The whole country is interested and needs an American merchant marine not only for commercial but also for military reason; hence, the whole country and particularly the industry of the country that is served and protected by this merchant marine must needs contribute something for its support.

Conclusion

In this article an attempt has been made to point out several practical points that vitally affect the economical operation of United States shipping. The control of some of these matters may be invading the vested rights of long established custom. The United States cannot, however, get something for nothing. We cannot have a United States merchant marine simply by wishing for it or by having the Emergency Fleet Corporation give contracts for a lot of ships, or by publishing lists of these contracts and estimates of how much shipping we hope to have by 1925, etc.

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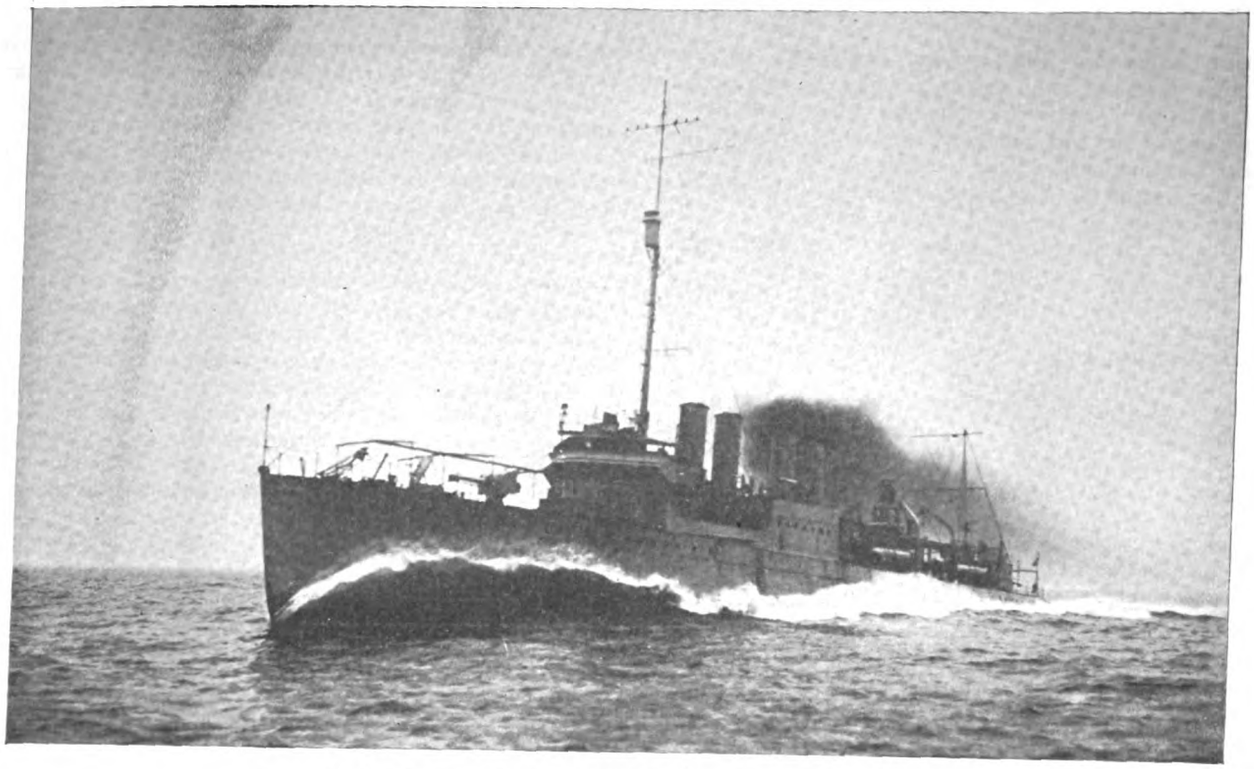

United States Destroyer "Reid" on Her Trial Trip

A World's Record in Shipbuilding

Squantum Works of the Bethlehem Shipbuilding Corporation, Ltd., Builds Destroyer in 45 Working Days

AT THE time this country entered the war, the Government found itself extremely short of that most essential type of naval vessel, the destroyer. The necessity for these boats was so forcibly shown by the experiences of our navy abroad that the secretary of the navy awarded to the Bethlehem Shipbuilding Corporation, Ltd., what is said to be the largest contract ever given out in the history of the world. This contract covered the construction of ninety-one destroyers and the building of a complete new plant for manufacturing them. Twenty-five of these destroyers were given to the Union plant of the Bethlehem Shipbuilding Corporation, Ltd., at San Francisco, and, of the balance, thirty-six were allocated to the Quincy works of the Fore River plant of Quincy, Mass., and the remaining thirty-five to the proposed new shipyard at Squantum known as the Squantum works of the Fore River plant. This undertaking made it necessary to construct, in addition to the shipyard itself, a turbine shop at Buffalo, known as the Black Rock works, and a boiler shop at Providence, R. I., known as the Field's Point works. These two works, together with the Quincy and Squantum works, comprise the Fore River plant under the management of S. J. Wakeman. The work was thus distributed between three industrial centers, so as to leave the labor market undisturbed at Quincy.

Ship Production at the Squantum Works

On September 7, 1917, ground was broken for the new shipyard at Squantum. The site chosen was a tract consisting of 366 acres of bleak marsh land, owned formerly by the New York, New Haven and Hartford Railroad. The following winter, the most severe in years, will always be remembered by those first men at Squantum. The plant was constructed in the face of inconceivable difficulties, and the first months of shipbuilding brought even more trying conditions. But the men were not to be discouraged. Gradually the wheels turned faster and the work progressed more smoothly. The following November, scarcely a year after the ground was broken in the construction of the plant, the first ship was delivered to the navy. October of this year, therefore, marked the second anniversary of the plant which had at that time a record of twenty-two deliveries, twenty-nine launchings, and keels for the entire contract laid. The rate of production which has at the present time been attained by the Squantum works is shown by the record of five deliveries and two launchings during July, and four deliveries and six launchings during the month of September.

Building a Destroyer in 45 Working Days

Not content with these records, the Squantum works has established a world record by building the destroyer *Reid* in 45 working days—a reduction from the previous record of 174 days held by the same plant at the Quincy works. At the time the U. S. S. *Reid* was laid down, sixteen other ships were building. From September 9 when her keel was laid until November 6, when she was delivered, five other destroyers were launched and six delivered. The *Reid* was the first November delivery from Squantum. But before the month was over three more deliveries were added, and during December three additional boats will be turned over to the Navy Depart-

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ment. This ship went through exactly the same procedure as every other destroyer built for and accepted by the Navy Department. She passed the regulation tests and inspections and underwent the same trials and post-trial examinations. If the inspectors made any exception in the case of the *Reid,* it was to make their inspections more rigid. So the *Reid* stands, not as a freak built under special conditions, but a well-tried ship, complete in every detail and ready for immediate service.

Representing the most modern type of destroyer as developed during the war, the *Reid* is 310 feet long between perpendiculars, with a molded beam of 30 feet 11½ inches, and a molded depth of 20 feet 8 inches. Her trial draft is 9 feet 5 inches and her trial displacement 1,215 tons. She is equipped with four oil-burning boilers of the Yarrow "express" type, operated under the closed fireroom system of forced draft and supplying steam at 265 pounds pressure. Her oil tanks store enough fuel to give her a cruising radius of more than 4,000 nautical miles. Propulsion is by Curtis turbines developing 27,500 horsepower, driving the ship through reduction gears at a maximum speed of 35 knots. The ship's armament consists of four 4-inch guns, one anti-aircraft gun, and four 21-inch triple torpedo tubes. The *Reid* also has provisions for installing the "Y" gun and stern-releasing gear for scattering the depth charges which proved so disastrous to German submarines. When commissioned, the *Reid* will have a complement of six officers and 96 men and will be detailed to the Pacific Coast.

How the World's Record Was Made

The keel of the *Reid* was laid on September 9 at 7 a.m. Before the first day's work was finished, five bulkheads were erected, the reserve feed tank was assembled complete, the boiler room tank sides were in place and the erection of frame and shell plating had already commenced. By the end of the second day, the keel was practically laid, the stern, the bow section, the stern frame and practically all frames and bulkheads were erected. On the fifth day the pipe fitters started fitting fuel oil lines to the forward tanks and three days later the sheet metal workers and electricians were at work on the ship. By October 1, 17½ working days from the start, the hull, with the exception of a few deck and shell plates, was completely erected. Meanwhile riveting was progressing at a rapid pace. On this same day, the machinists started work on the sea chests and the sheet metal workers began the installation of corrugated bulkheads in the officers' quarters. Three days later, on October 4, the hull department started the first water test, filling the reserve feed tank. The pipe fitting was proceeding rapidly and the electricians were welding hangers and clips all over the ship. The machinists had burned out the sea chests and air ports and had already started the installation of auxiliary machinery. During the next few days the water tests proceeded. The riveting was rapidly cleaned up, the rudder line passed and the rudder installed. On Saturday, October 11, the shaft line was run and the boring completed. The shafting and propeller were installed the first of the following week. On October 14 the hull department finished all water tests and began air testing.

The following day, October 15, the vessel was launched at 4:30 p.m. At the time of launching the boat was completely water tested and several air tests were already passed. The foundations were complete and the forward and aft deckhouses erected. All auxiliaries were installed except three units, which could not be put in the ship until after launching. The trunks for the forced draft blowers had been fitted and the scuppers and propeller guards finished. A good start had already been made on the shelving in the storerooms and magazines and most of the main pipe lines had been fitted. The electricians had completed over half of the layout work and the pulling of cables had already begun.

Fitting Out and Testing the Ship

After the launching, the work moved, if possible, more rapidly than before. The hull department erectors had already begun taking off the deck before the boat was docked. By 7 p.m. the deck was stripped and the installation of boilers started. At 2 a.m. the following morning the first condenser was installed and by 12 noon all machinery was located permanently in the ship. On the morning of October 17, two days after launching, the galley was erected in one unit. It was immediately followed by the erection of the four stacks. The same morning bricking was started on the boiler furnaces and the first fitting was made on the main exhaust trunks. On October 18 the shafting was passed for alinement and the first boiler hydrostatically tested. The boiler room tanks were filled with oil and the 24-hour oil test began the following Monday. The first steam test was passed on October 21 and, on the same day, the art metal furniture was started in the staterooms and the metal sheathing in the crew's quarters. On Thursday, the 23rd, the first linoleum was laid in the petty officers' quarters and on the same afternoon both masts were stepped. Steam was put on the ship Friday and current was operated for the first time. The spinning test and dock trial were successfully completed on Monday, October 27. The following day the builders' trial was run with an average of 454 revolutions. Three days later, October 31, the ship successfully ran her official trial and was accepted by the trial board. On the following Thursday, November 6, having completed her post-trial examination, the U. S. S. *Reid* was delivered to Charlestown Navy Yard with appropriate ceremonies.

Individual Records

There are many interesting figures in connection with the building of the *Reid.* Over 200 tests and inspections, in addition to tank tests, had to be passed during the construction of the ship. Some idea of the speed of production can be obtained by considering that twenty-two tests were passed in one day. In running the shaft line, boring and installing the shaft and propellers, all previous records were shattered when the whole was accomplished in less than 24 hours. The entire ship, consisting of 51 compartments, was water-tested in nine working days and passed her boiler room tank for final inspection two days after launching. All of the main machinery was installed in eight hours. The furnace pans were ready for bricking on the second day after launching and bricking was finished on the fourth day. Targets were taken for all of the main steam expansion bends and the pipes installed in three and one-half days. Ninety percent of the pipe covering throughout the ship was completed in five nights' work. The greatest rivet drive for a single week was 160,000 rivets and an average of sixty-six rivets per gang hour was maintained up to launching.

All of this work was accomplished without any overtime work and without any night work except those details which could not be conveniently done on the regular shift.

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Some New Developments in Diesel Engine Construction in the United Kingdom

BY OUR SPECIAL LONDON CORRESPONDENT

NEVER previously has such interest been taken in Great Britain in the problem of construction of motorships as at the present time, and while this is to a certain extent due to the extremely high price of coal and to Lord Fisher's campaign in favor of internal combustion engined warships and mercantile vessels, it is essentially an outcome of the normal process of evolution. There are now very few marine engineers and shipbuilders in the country who are not convinced that the future lies with the motorship, and while they are one and all continuing with the construction of steamships and steam driven machinery as an immediate necessity, the majority are laying plans for the future building of large motor vessels as standard types.

The most interesting feature of this development from the standpoint of the marine engineer is perhaps that almost every firm of note is producing its own special Diesel engine, differing radically from all other types, and, to name only a few, Vickers, Armstrong, Doxford, Scott, Cammel Laird, Swan, Hunter and Wigham Richardson, and Harland & Wolff, are all building motors of their own designs, although in one or two instances they are based upon Continental engines. About half of the engines are of the two-cycle and half of the four-cycle type, while a noteworthy feature is that at least one concern is developing both, with a view to adopting the latter in moderate powered ships, and the former for much larger vessels.

A New Double-Acting Diesel Engine

An example of this is afforded by the North British Diesel Engine Works, established on the Clyde, whose factory has been laid out for the construction of marine oil engines up to 12,000 brake horsepower in six cylinders. They are now manufacturing four-cycle motors of 1,800 brake horsepower, in addition to which they are laying plans for the construction of two-cycle double-acting motors, of an entirely new design. This is all the more interesting in view of the fact that the works were originally erected for the production of Diesel engines of the Krupp type, including the double-acting machine made by the German firms. This has now been abandoned and the new motor will be on entirely different lines.

Its main feature lies in the method employed for scavenging and in discharging the exhaust gases, while the system of fuel injection at the bottom of the cylinder—always a difficult problem in double-acting engines—is quite novel. In the center of the cylinder are two sets of ports opposite to each other, one set for the exhaust and one for the admission of the scavenging air, each occupying a total of about one-third of the periphery. Each set of ports leads into a chamber in which is a piston valve operated from a cam shaft through the necessary levers. On the downward stroke of the piston the valves remain closed until the correct time for exhausting, when the valve controlling the exhaust ports is opened, followed by that regulating the entry of the scavenging air, which thus drives out all the spent gases and fills the cylinder with pure air, ready for the compression stroke. The valves are then closed and the action is repeated on the upward stroke of the piston, and it may be noted that with this design the piston can be relatively short.

In order to avoid the uneven combustion and the consequent unequal distribution of the pressure over the bottom of the piston, due to the obstruction to the fuel jet caused by the piston rod, double-acting Diesel engines have usually been built with two fuel valves in the bottom cover. The North British Diesel Engine Works' design overcomes this difficulty by forming a recess in the bottom of the piston itself, this recess acting as a combustion chamber, while the piston is shaped as closely as possibly to the cylinder cover with very little clearance. The recess is made by having a ribbed conical enlargement at the top of the piston rod, the enlargement being fixed to the bottom of the piston. The fuel is injected through the space between the ribs and is thus directed right into the combustion chamber without its passage being impeded in any way. By this means it is claimed that very efficient combustion and equally distributed temperature and pressure are attained. The piston is, of course, water-cooled, and the whole design appears to be well adapted for engines of very large power. The development is of particular interest at the moment, as suggestions are on foot for building some large passenger motor-liners.

13,000-Ton Motorships

The first of the four 13,000-ton deadweight motorships for the Glen Line will shortly be completed by Harland & Wolff and it is not unlikely that still larger vessels will be laid down, while a vessel of similar size will be put into commission before the end of this year by the East Asiatic Company, built by Burmeister & Wain at Copenhagen, who have now sufficient motorships on order to keep them busy until 1927. In the Glen liner two 3,200 indicated horsepower eight-cylinder engines are installed and the now standardized practice of driving all the auxiliaries by electricity will be followed, as this has been found more economical and convenient than the installation of a boiler and the use of steam winches, steering gear, etc.

A 3,000-Horsepower Four-Cylinder Engine

The 3,200 indicated horsepower engine represents an output of 400 indicated horsepower per cylinder, but in view of the discussion concerning the maximum power per cylinder which can be developed in a Diesel engine the 3,000 indicated horsepower motor which will shortly be completed by Wm. Doxford & Sons for a 10,000-ton single-screw cargo ship is still more interesting. This engine has only four cylinders, 750 indicated horsepower per cylinder, and is by far the largest example of the opposed piston or Junkers type that has yet been built, although Doxfords have had an experimental cylinder of almost equal power, running for some years. It is really a low compression engine with a compression pressure of 360 pounds per square inch instead of the usual 480-500 pounds per square inch. This favorable condition is achieved by maintaining the top of the piston at high temperature during the cycle, so that the temperature of the compressed air, and therefore its pressure, may be much lower than in Diesel engines of orginary design.

The Doxford motor has other unusual features, one of which is that solid injection of fuel is used, and another that it runs at the low speed of 77 revolutions per minute, which is eminently suitable for a cargo ship. The experimental engine has operated for several days continuously at 25 revolutions per minute, which indicates the wonderful degree of flexibility possible with this type of motor.

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Electric Propulsion of Merchant Ships

Results Obtained With Electrically Propelled Ships—Advantages Claimed and Comparison With Geared Turbine and Reciprocating Engine Drive

BY W. L. R. EMMETT

THE use of electricity for propelling ships was first advocated in the case of large warships in which it affords particular advantages in the matter of cruising economy through change of speed ratio, interchangeability, space distribution, etc. The first application, however, was made in the case of the United States collier *Jupiter,* which is in most features a ship of the merchant type. The demonstration of geared-turbine propulsion came after the first serious proposals of electric drive, and the advantages which have been attributed to the geared method have suspended such activities as were considered in this country in the direction of electric drive for merchant ships, while, in the case of warships, electric drive activities have been uninterrupted. In the meantime certain electrically driven ships built in Europe, operated with very high degrees of superheat, have shown wonderful fuel economy, and many more such ships are being equipped.

The larger American shipbuilders, having their own facilities for machinery construction, have, not unnaturally, been opponents of electric drive, and the Emergency Fleet Corporation, which for some time has represented ownership, has for various reasons discontinued such activities in this direction as had been planned.

Two or three years ago the writer was of the belief that the geared equipments then being made afforded a solution of the problem which in cost and results would probably prevent commercial success of electric drive in merchant ships, although it was realized that the margin of possible advantage was small. Since that time improvements in electrical designs have been developed, and limitations of gear possibilities have appeared which put the question in a different light, and it is now the writer's belief that electric drive is justified in all large ships and that it will very soon develop a wide application, notwithstanding the great efforts of skill, organization, and capital which have been given to the introduction of the gear drive for vessels of all classes.

The discussion of this subject is largely a matter of comparison with other methods, and the purpose of this paper is to make clear what is proposed in a specific case and to suggest comparisons which may affect relative value.

The case selected is that of a vessel of 8,800 deadweight tons, length 424 feet, beam 54 feet, having a cubic capacity of 460,000 cubic feet and capable of making 11.5 knots with 2,500 shaft horsepower delivered to a propeller operating at 100 revolutions per minute. Fig. 1 shows an electric propelling equipment applied to such a ship, and, for comparison, an equipment with triple-expansion engines is shown in Fig. 2. It will be observed that in this design the motor is placed as far aft as convenient, affording space for disassembling and for removal of the tail shaft. The generating unit and controlling equipment are placed near the boilers in such a manner as to afford a maximum convenient saving of cargo space, the condenser being suspended below the turbine in the same compartment with boilers. The auxiliaries are distributed in convenient locations in the turbine room and in the space below near the condenser.

*Paper read before the Society of Naval Architects and Marine Engineers, New York, November 14, 1919.

The weight of this equipment, including generating unit, motor, controlling mechanism, and direct current exciter, will be about 67 tons.

Auxiliaries

In connection with such equipments it is proposed to use, as much as possible, electrically driven auxiliaries. It is necessary to maintain an electrical supply independent of the main generator for purposes of excitation and lighting. The losses involved in the operation of larger auxiliary generating equipment are relatively much less, and there is no increase of complications. With such an equipment it is proposed to install two 150 kilowatt, turbine-driven, direct-current auxiliary generating units, one being required for service and the other installed as a spare. Excitation and lighting will only amount to 40 kilowatts, leaving 110 kilowatts available for any possible auxiliary uses. A little more than half of this should be sufficient for normal conditions. While the ship is at sea, for reasons of simplification and economy, it is proposed to exhaust the auxiliary generating unit into one of the lower stages of the main turbine at a pressure somewhat above the atmosphere, so that some of this exhaust steam will be available for feed heating if that obtained from steam-driven auxiliaries is insufficient. In port these auxiliary units would be exhausted into an auxiliary condensing plant which would be idle while the ship was at sea.

Motor Compartment

The motor carries the thrust bearing and is also equipped with a simple, slow-moving oil pump which maintains automatic lubrication in the motor compartment. This lubrication can be arranged with a storage tank and with an emergency drip supply to the low-speed bearings contained in the after compartment, so that, even if the oil pump should fail, many hours might elapse before injury could result to any of the bearings. With such an arrangement the self-lubrication of this compartment becomes entirely simple and safe, and with occasional inspection it should be operated without an attendant and without any passage connecting it with the engine-room; in fact, there is nothing that an attendant can do in this compartment, and there would be quite as much reason for keeping an attendant on the truck of an electric locomotive where the electrical and lubricating conditions are far more complicated.

Space Saving

It will be observed that the omission of the shaft alley and the diminution of space required for the engine room materially increases the cargo space and simplifies its shape. This increase amounts to something over 12,000 cubic feet, nearly 3 percent of the total capacity of the ship. The omission of the shaft alley, shafting, and supporting bearings effects a weight saving of about 60 tons, and there will be an additional weight saving in the machinery itself since the electrical equipment will weigh about 9 tons less than the engine equipment for such a ship.

Economy

If this equipment is operated with 200 pounds steam pressure, 200 degrees F. superheat, and a vacuum of 28.5 inches, the steam consumption per shaft horsepower hour.

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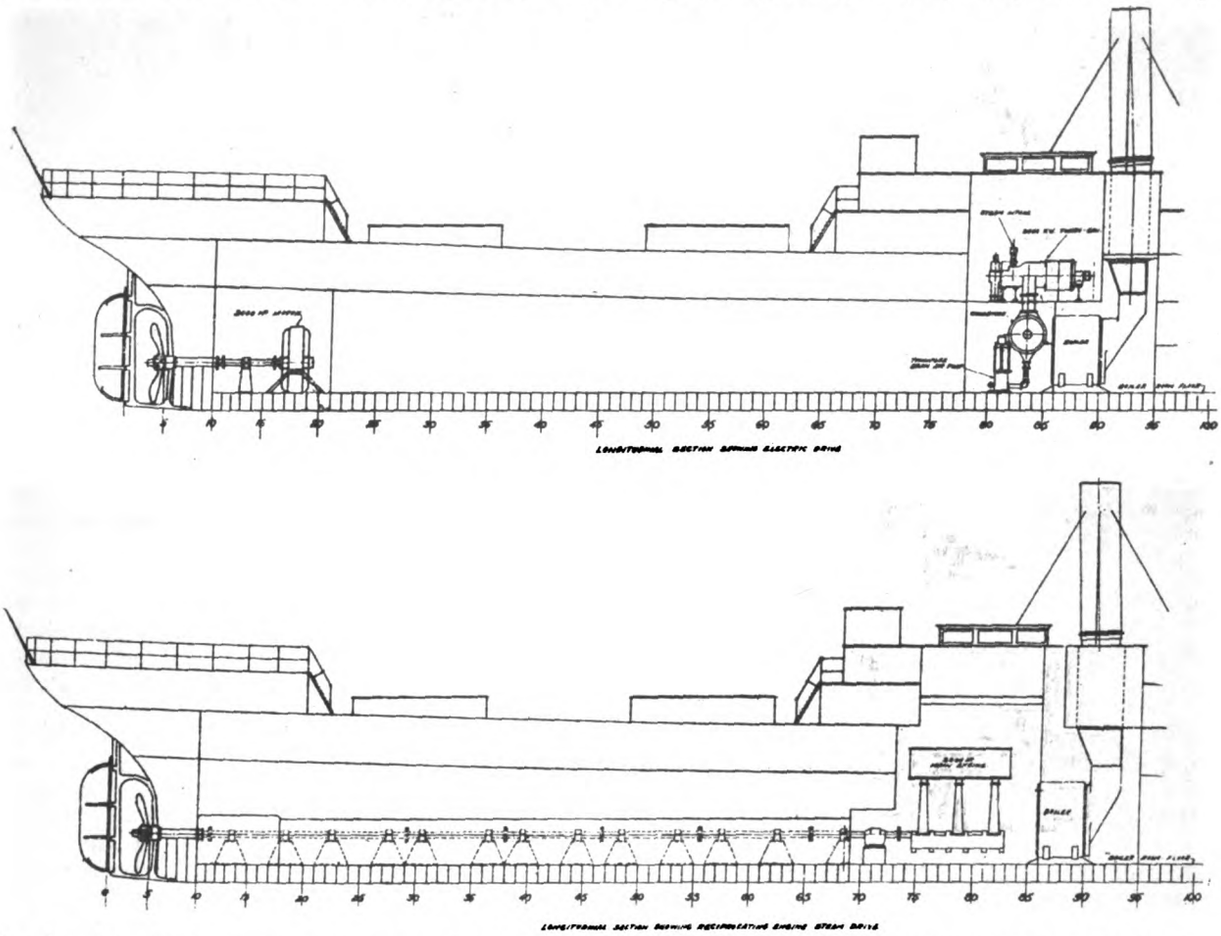
not including auxiliaries, will amount to 9.5 pounds. Under normal conditions at sea, with most of the auxiliaries driven electrically, this should give a steam consumption for all purposes not greater than 11 pounds per shaft horsepower hour. Such a steam consumption will require at least 30 percent less fuel for all purposes than would be required by a good reciprocating engine equipment operating without superheat, and even if an equal superheat were used with a reciprocating engine equipment, the gain would still be over 20 percent.

In this connection it must be considered that large numbers of American ships are now being equipped with reciprocating engines and without superheat, although it has been amply demonstrated abroad that the use of high superheat is practical and economical.



Figs. 1 and 2.—Machinery Arrangement of 8,800-Ton Ship Equipped With Electric and Reciprocating Engine Drive

If such a ship were in operation 250 days in a year between California and Australia, burning fuel oil at $1.00 per barrel, the saving in fuel over a similar engine driven ship operating without superheat would amount to about $17,000, and the increased freight capacity leaving California would amount to 585 tons, which is 7½ percent of the deadweight tonnage.

Reliability

A study of the records and uses of such electrical apparatus as is applied in this case will show that the equipment is less liable to interruption of service than any other form of single-screw equipment which is applied to vessels. With such an equipment, however, arrangements could easily be made by which the ship could be navigated about half speed with the main generating unit out of service. This could be done by providing a motor-generator set or rotary converter so arranged that the power of auxiliary generating units could be delivered to the main motor. In an electrically propelled ship, electricity is produced simply for one definite purpose, and the arrangement is simpler and more reliable than shore applications, where power is taken from large distributing systems. It is also possible to provide automatic means which, by interrupting excitation, guard against the possibility of serious damage through possible accidents or insulation failures. Such electrical apparatus of the type used in ships is very easily repaired, and, even when damaged, can generally be temporarily connected so as to be operative. The knowledge necessary for such repairs is very easily imparted and is constantly being practiced in our industries by persons who have had little or no electrical training.

Reliability of Gearing in Ships

To make comparison of such an equipment with a gear-driven ship is much more difficult, since a great variety of arrangements of turbines and gears have been applied to ships of this type. In the matter of reliability, as has been said, the electrical equipment is entirely beyond question, while many evidences of serious trouble and deterioration have developed in geared ships of most types which have been produced. Gears have been very successful in many warships, but these are subject to only occasional short periods of high-power service. In some merchant ships gears have been very successful, and in others most serious trouble has been encountered. Variations of results in similar equipments in different ships illustrate some of the possible uncertainties. Parsons'

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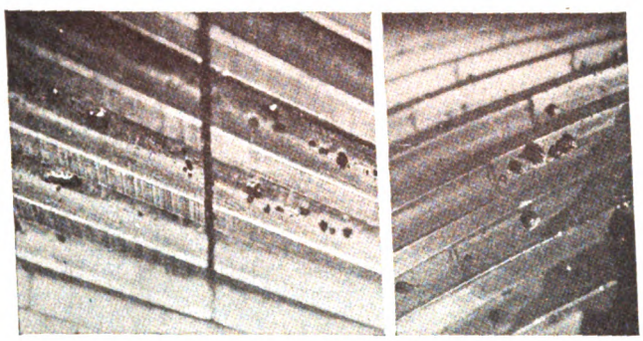
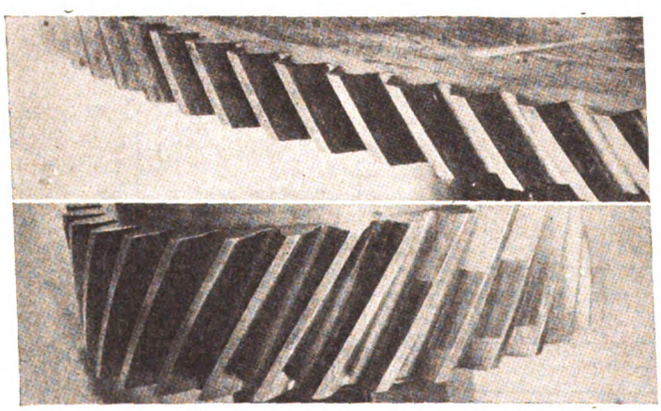
original gear applications operated with a single reduction, very small diameter pinions, and a large diameter gear on propeller shaft. Some of these have been reported to be very successful, but the gains in economy shown in Parsons' publications are nothing like so great as those accomplished by high-speed turbines with double reduction gears. There have, however, been many cases of failure with gears of this type. In fact, there seems to be no type of gearing with which trouble has not been experienced after long service in cargo vessels.

Recent production of so-called "Standard English ships" shows they are being equipped with double reduction gearing, and at the same time that this change of method is being adopted in England, the use of single reduction is being extensively advocated and applied here. Although all the original American equipments in merchant ships were double reduction, the writer has seen a solid-gear, double-reduction equipment of American make in which the gears were badly worn and pitted after 17,000 miles of service, and in this case the proportions of gears are closely equivalent to those which have been adopted in the new standard English ships, and the conditions of design and manufacture quite as good.



Low Speed Ship Gear and Pinion. Pinion Diameter, 11.44 inches. Pitch, 3½ inches. Normal load, 1,150 pounds per inch face. Tooth speed, 1,272 feet per minute. Time run, about 400 hours at sea.



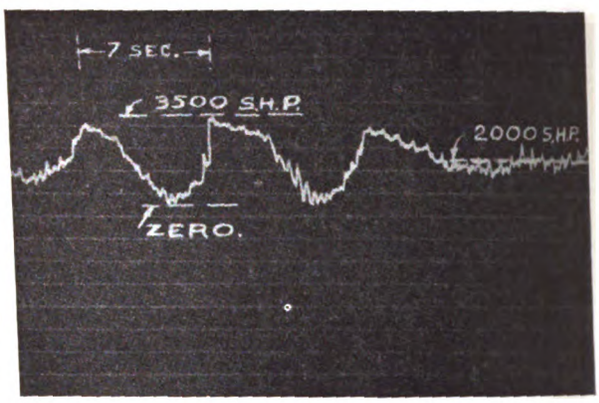
Experimental Gear Disk and Pinion. Pinion diameter, 7.28 inches. Pitch, 4 inches. Load carried, 3,000 pounds per inch face. Tooth speed, 7,000 feet per minute. Time run, 263 hours in Schenectady. Has made 8 times as many tooth engagements as above with a pressure, which, considering smaller pinion diameter, is relatively 4 times as heavy.

Fig. 3

These indisputable facts and many others certainly indicate that gearing for ships has not yet reached a state of finished development.

One of the uncertainties of gear operation in ships is illustrated by the very great difference in durability of gears in ship propulsion and in shore uses. In trials on shore, gears have borne without blemish, for equal periods, loads equivalent to approximately four times the average loads which have caused bad destruction of similar gears at sea. This is illustrated by the photograph shown in Fig. 3, and the data there given are characteristic of many other similar experiences which have developed.

The reasons for these astonishing differences have never been adequately explained. Fig. 4 shows a record taken from a torsion coupling on a cargo vessel operating in ballast in a moderate seaway. This record shows that the torque on propeller shaft varied from zero to approximately 75 percent overload under certain wave conditions. The effect of bad weather on endurance of gears has often been observed, and it is quite possible that variations much greater than that here shown may at times be experienced. In this case the ship was pitching only 4 degrees. Part of the small, quick variations shown in this record were caused by a transmitting ring which ran slightly out of true in the instrument, but otherwise the conditions were such that the record must be substantially correct.



Record for Torsion Spring Coupling on S. S. *Jebsen* in ballast in a moderately rough sea. Average R. P. M. 78. Average shaft horsepower, about 2,000. Part of the smaller fluctuations shown came from an untrue collar in the instrument, otherwise record is correct.

Fig. 4

Another matter of uncertainty in geared-turbine equipments is the matter of temperature in turbines. The operation of turbines in the reverse direction occasions large temperature variations, and temperature variations constitute a fruitful source of danger to turbine structures. Fig. 5 shows a record for temperature taken by a pyrometer situated between the nozzle and bucket of the last stage of a marine turbine while the turbine was being operated at normal speed in the reverse direction. It will be observed that the high temperatures shown by that record were produced in an extremely high vacuum by the introduction of small amounts of steam.

A turbine when operated in the reverse direction has a friction loss something like ten times as great as when it operates in a normal direction. In the General Electric shops it has been discovered that reversing wheels of marine turbines turn blue with heat when operated at normal speed in a vacuum of 20 inches. While no definite information can be given concerning the possible effects of high superheat in reversals of a marine turbine, the facts here given indicate that such effects may be serious and should, if possible, be avoided. A turbine which is kept running in its normal direction is not subject to any large temperature variations. The economies incident to the use of superheat on shipboard are very great and cannot long be neglected, although there have been few applications of superheat to American ships. The following extract from a letter from Van Nievelt, Gou-

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driaan & Company, Rotterdam, Holland, illustrates the superheat possibilities in engine-driven ships:

"We are using during the last five years, in our multitubular boilers, 3½-inch tubes, very high funnels and Diamond blowers, and have no trouble at all in getting sufficient steam. We have practically no leakage at the connections of the pipes and boxes. The original pipes are still in use. The capacity of a 20-ton evaporator is sufficient for supplying feed water.

"Three of our steamers have been running half a year without superheaters, with a coal consumption of 24 to 25 tons. After fitting superheaters the consumption was about 22 tons, making a saving of at least 10 percent."

In electrically-driven ships the gain is quite as great as is here shown, and no practical difficulties can result even from degrees of superheat which would be impracticable with reciprocating engines.

EFFICIENCY OF TRANSMISSION

The selection for comparison of a ship of low power is unfavorable to the electric drive in the matter of transmission efficiency, the conditions being better for this method in ships of higher power. The generator designed for this case has an efficiency of 95.6 percent and the motor 95.9 percent, making the transmission efficiency, including cable loss, etc., 91.6 percent. In machinery designed for certain high-power ships, the efficiency is as high as 94 percent.

To determine the efficiency of gear transmission as compared with the figure given above, very careful tests

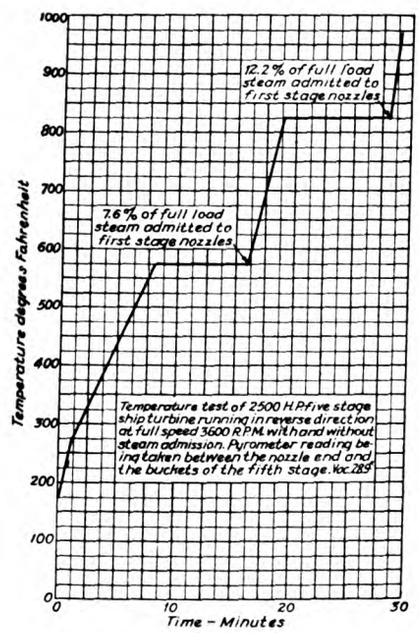
12.2% of full load steam admitted to first stage nozzles
7.6% of full load steam admitted to first stage nozzles
Temperature test of 2500 H.P. five stage ship turbine running in reverse direction at full speed 3600 R.P.M. with and without steam admission. Pyrometer reading being taken between the nozzle end and the buckets of the fifth stage. Vac. 28.9
Temperature degrees Fahrenheit
Time - Minutes
0
100
200
300
400
500
600
700
800
900
1000
10
20
30

Fig. 5

have been made at Schenectady. A 2,400 horsepower ship turbine was connected through two sets of double-reduction gearing to a generator, and the steam consumption was tested at various degrees of load and speed; then the same turbine was connected to the same generator without gearing, and tests were run with the same conditions and the same degree of steam flow. All this was done on a testing stand where conditions are uniform and accurate; the gears ran with perfect smoothness, and all conditions were favorable. Since the comparison gives the loss of two gears, the differences are considerable and the determination should be very close to the correct value. This test showed that the performance of a single gear is as follows:

Shaft Horsepower	Revolutions per Minute	Loss of two sets of gears	Efficiency of gears
2,400	87	250 horsepower	95.0%
1,420	77	160 horsepower	94.7%

In addition to these gear losses, we must also consider the loss in friction of the reversing turbine, which is estimated from reliable data to be 28 horsepower, and we must also consider the bearing losses on about 100 feet of shaft, which in perfect alinement will be 8.5 horsepower. These additional losses reduce the transmission efficiency to 93.5 percent, leaving only 1.9 percent advantage to the gearing. With shaft more or less out of line and gears operating under sea conditions, it is probable that the losses given would be greatly increased. Noise is an indication of loss, and most marine gears are at times noisy, while the gears in this test were almost silent. The gears tested in this case were of the General Electric Alquist type, and it might be claimed that other kinds of gears would be more efficient, but it is obvious that, under fixed load and with similar gear speeds and diameters, there could be no advantage in any other type, even if it ran with equal smoothness.

COST

In the present condition of prices it is very difficult to compare costs, but the cost estimates of the General Electric Company on electric equipments for cargo boats and geared equipments of recent design indicate that the electric is slightly cheaper. If we consider savings in shafting support, shaft alley, oiling system, etc., the saving with electric drive should be as much as 20 percent of the cost of the driving machinery.

PROPELLER SPEEDS

In ships requiring less than 3,000 horsepower, there is some practical disadvantage in using propeller speeds below 100 revolutions per minute, because of the large number of motor poles required if a high-speed turbine is adopted. Studies recently made by the Navy Department and elsewhere have indicated that there is practically no disadvantage in using a propeller speed of 100 revolutions per minute on an 11-knot, 3,400-horsepower ship, but in all cases of electric drive the matter of propeller speed should be carefully studied. In ships of higher power it is not desirable to use extremely high turbine speeds, and therefore there can be no difficulty about propeller speeds. Even in low-power ships, lower turbine speeds could be used if expedient, but this is disadvantageous to a small turbine, and the relative advantages and disadvantages should be duly considered.

OPERATING FORCE

The history of the electrical industry has repeatedly shown that persons who have not used electrical apparatus assume that its operation requires a high order of skill and expert knowledge, and of this assumption we have already heard much in connection with electric drive for ships. A vast amount of experience had repeatedly shown that this assumption is the direct reverse of the truth, and a little thought as to the conditions in electrical apparaus should make the reason obvious. Conductor circuits are much simpler mechanically than pipes and mechanical motions, and electrical machinery is simply a combination of electric circuits with motion of rotation. The connections are easily shown by diagrams, and little mechanical skill is required to make them. The work of insulation can be so done that, under such conditions as exist in ship installations, troubles which might involve difficulty of repair by unskilled persons are very improbable. In all the extensive uses of electricity in mills, mines, railways, and other industries, it has seldom failed to immediately become popular with the operating forces.

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Elecrical Repairs on Ex-German Ships

Nature of Damage to Electrical Equipment by Sabotage—Alterations and Replacements —Generators and Motors, Lighting and Communication Systems

BY JOSEPH STANSBURY JONES*

VERY little has been known until recently of the measures taken by the Government to utilize the German ships interned in the early days of the war as troop transports, cargo carriers, animal transports and the like. Not the least important of the repairs made necessary by the destruction of machinery by the ships' crews was that of the electrical equipment which, originally of inferior quality, was hopelessly ruined by sabotage.

When this country entered the war there were 109 interned German and Austrian ships in the ports of the United States and its possessions, comprising 95 (610,265 tons) Germans and 14 (67,817 tons) Austrian. These ships represented a total gross tonnage of 678,082. At the port of New York in the third naval district the following eleven ex-German ships and one ex-Austrian ship were interned:

Former Name	Present Name	Length in feet	Gross Tonnage
Grosser Kurfurst	Aeolus	560.6	13,102
Kaiser Wilhelm II	Agamemnon	684.3	19,361
George Washington	George Washington	699.1	25,570
Friederich Der Grosse	Huron	523	10,771
Vaterland	Leviathan	907.6	54,282
Koenig Wilhelm II	Madawaska	490.4	9,410
Barbarossa	Mercury	526.3	10,984
Princess Irene	Pocahontas	523.5	10,893
Hamburg	Powhatan	499.3	1,053
President Grant	President Grant	599	18,072
President Lincoln	President Lincoln	598.8	18,168
Martha Washington	Martha Washington	460	8,312

These ships were selected by a joint board as being suitable as troop transports. After a thorough survey, they were distributed to various shipyards for the purpose of making necessary repairs and alternations to fit them for their future uses.

Generators and Switchboards

An inspection of the electrical equipment revealed that the commutators and the generators had been smashed with sledge hammers, carbon brushes removed and destroyed, rocker arms and brush holders broken beyond repair, field and armature windings damaged and acid and ammonium chloride poured into the dynamo engine cylinders, causing corrosion of the pistons and rods. Needless to say, any operation of the sets so treated was impossible. The generating sets on several ships were so badly damaged that it was necessary to remove them to the repair shop. Other sets were repaired in place. All of them were put in shape in remarkably short order and were required to operate at full load for forty-eight hours before they were considered satisfactory.

Most of the ships mentioned were equipped with generating sets of an old type, usually of German manufacture, and, in general, arranged for single wire systems with selective control switchboards. Fig. 1 indicates the method of connecting the load to the generators. The

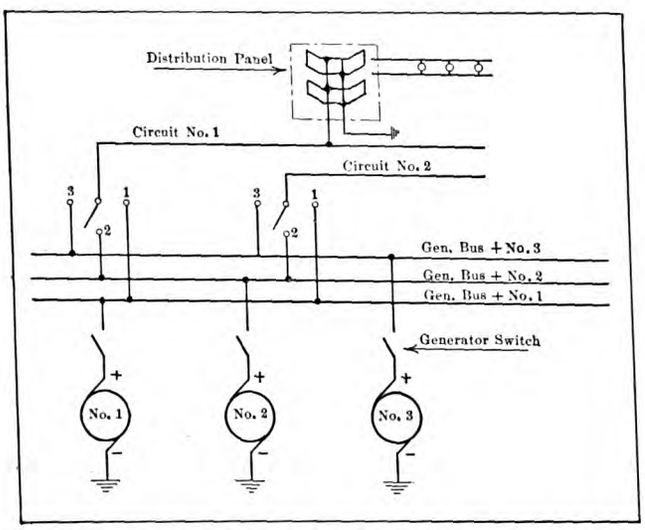

Fig. 1.—Method of Connecting Load to German Generator Sets

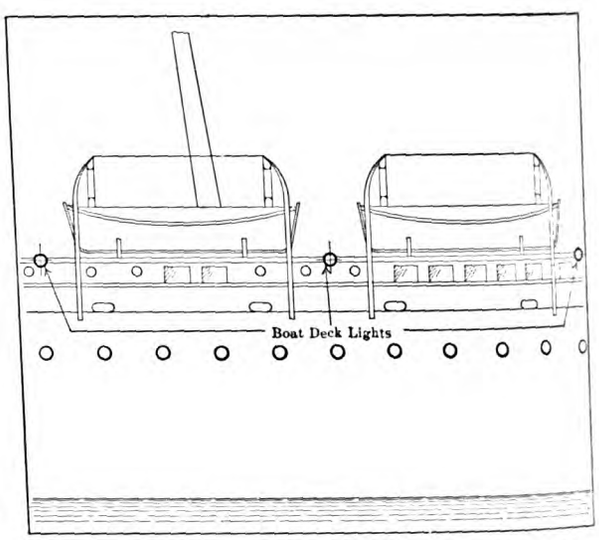

Fig. 2.—Auxiliary Lights Fitted on the Boat Deck

The wiring throughout the vessels consisted of a single conductor armored with spirally-wound steel tape. Insulating material on most of the wiring was in bad shape and caused many petty fires until it was replaced.

The superabundance of fixtures in the cabins and saloons lighted these spaces brilliantly while the machinery spaces and cargo holds were very poorly illuminated. All fixtures were of German design, highly ornate but not ornamental, and fitted with either single or double contact bayonet-type sockets. Many odd styles and voltages of bayonet based lamps contributed to the Hun idea of splendor.

Electrical Repairs

Upon undertaking the electrical repairs and alterations on these vessels, the greater part of the original installations had to be removed and replaced. Replacements were made with the best obtainable grade of commercial cable and wire. With the placing of all power and general lighting in a satisfactory operating condition, the question of additional electrical equipment to make these vessels suitable for use as troop transports presented itself.

*Engineer, Charles Cory & Son, Inc., formerly assistant electrical superintendent and senior electrical expert aide, Navy Yard, New York.

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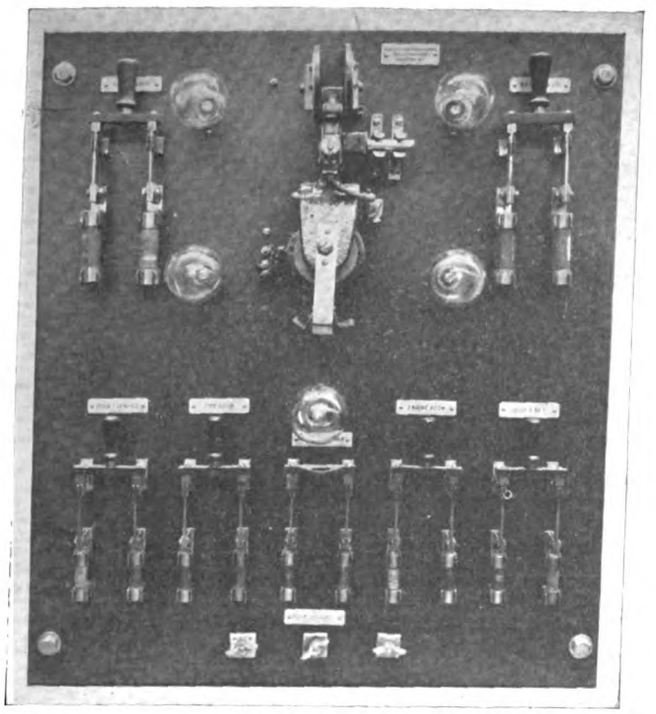

Fig. 3.—Arrangement of Relay and Distributing Panel in Radio Room

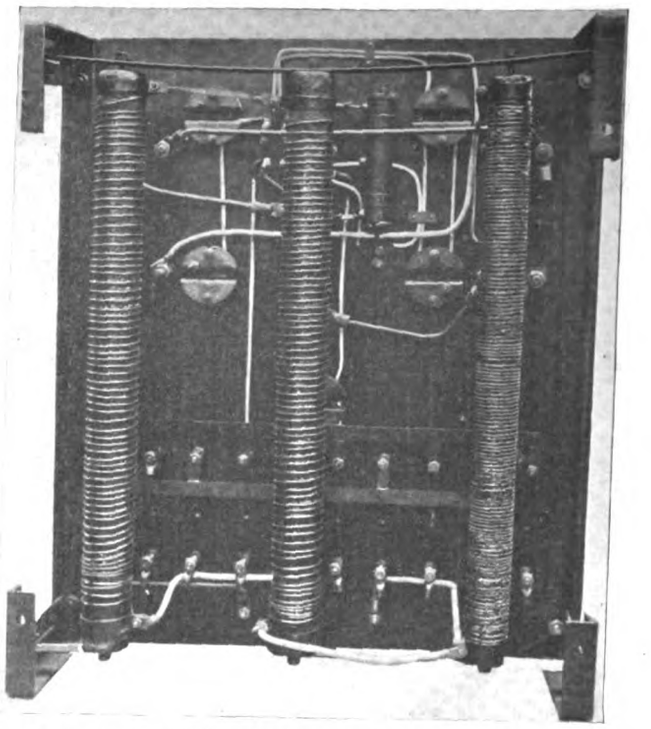

Fig. 3-a.—Connections for Relay and Distributing Panel

A list of commercial material considered suitable for marine use was compiled and distributed to contractors performing work on the ships in order that the best grades, as well as standardized equipment, might be installed. The number of different spare parts to be carried aboard ship was thus reduced. Conduit and copper-covered, armored cable were utilized in all machinery spaces so that the insulation would be watertight.

In the troop spaces the conduits were secured to the ships' frames instead of to the pillars. This means was taken to prevent damage by troops using the conduits for exercising purposes. Steamtight fixtures with globes and rugged guards were placed in all troop spaces to prevent the breakage of lights by troops during idle moments.

Boat Deck Auxiliary Lighting

For the boat deck system steamtight fixtures were fitted along the outboard strake on both the port and starboard sides between the adjacent boat davits. These lights, Fig. 2, were arranged for illuminating the boat-handling gear and the waterline to facilitate abandoning ship in case of a torpedo attack or from other causes. The auxiliary system was energized by a 25-volt, 140 ampere-hour, lead type storage battery located well above the waterline amidships and controlled by two double-pole, single-throw, knife switches inclosed in a metal case having a glass front.

Blue Exit Light System

A 140 ampere-hour, 110-volt lead type storage battery located on the boat deck in a suitable battery locker near the centerline of the vessel was used to energize the blue exit lights. This battery supplied current to circuits controlled through the relay and distributing panel, Figs. 3 and 4, located in the radio room. Current for charging the battery was supplied by any of the generators operating and fed through the main switchboard. The circuit feeding the relay-distributing panel was considered a battle circuit and was left on at all times. Fixtures were placed at all exits, troop compartments, crews' quarters, companion ways, engine rooms, firerooms, etc., but never in such locations as would be visible from outside the ship. All fixtures on this circuit were either of the deck or bulkhead type as required and equipped with steamtight, low visibility, blue globes and rugged guards.

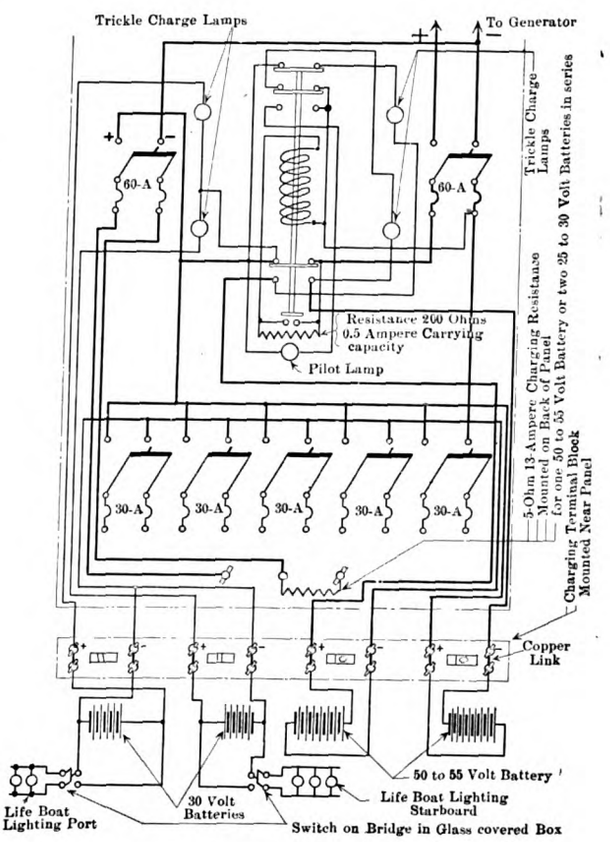

Fig. 4.—Wiring Diagram for Relay and Distribution Panel

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The standing light system consisted of a separate circuit from the main distribution board, energizing lights in each compartment and troop space and arranged to be kept on continuously when the ship was otherwise darkened. Sufficient lights were installed on the bulkheads, in compartments about 3 feet above the deck, to provide

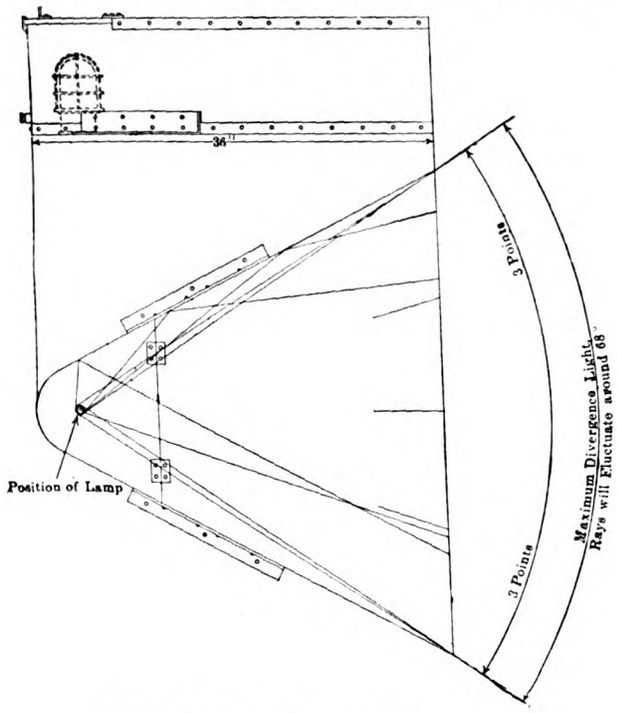

Fig. 5.—Screened Stern and Convoy Lights

adequate illumination for moving about. Lights were also placed at the scuttle butts, latrines, shower baths, etc., in order that these spaces might be used at all times.

A standing light system was installed to enable the crew to find their way around the troop compartments when the main circuit was extinguished for the night.

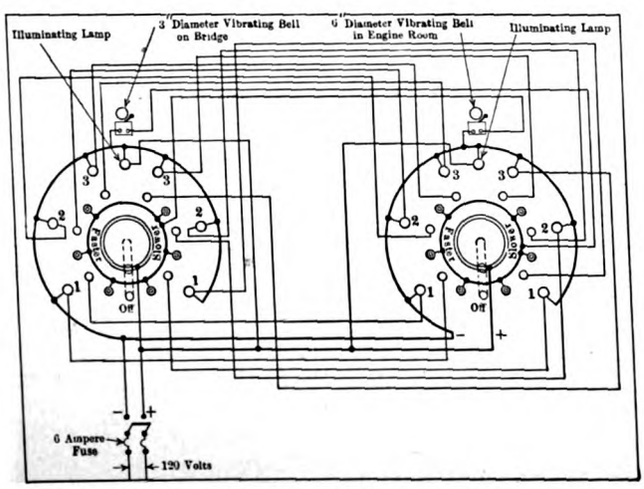

Fig. 6.—Engine Revolution Telegraph System Wiring

Each magazine was equipped with an individual standard magazine fixture energized from the auxiliary blue exit light circuit and controlled by a 5-ampere, watertight switch located outside the door leading to the magazine. A fixture in the bottom of the trunk leading to the magazine was placed in a position to reflect the light into the magazine when the door was opened. This light was controlled by a 5-ampere, watertight switch located at the top of the trunk leading to the magazine.

Two screened lights, known as screened stern and convoy lights, Fig. 5, were placed on the after side of the mast, one 60 feet above the other at the extreme stern of the vessel. These lights were operated by switches on

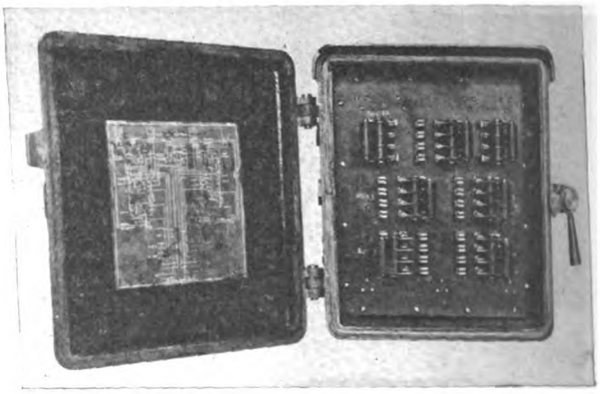

Fig. 7.—Master Station for Fire Control Telephones

the navigating panel in the pilot house. Their effective radius of illumination was from 3 points off the port quarter to 3 points off the starboard through an angle of 67½ degrees. The two lights at a fixed distance apart made possible the determination of the distance between ships by the triangulation method, so that they could maintain the proper intervals in convoy as well as maneuver at night in safety. Low visibility blue lamps, invisible to the eye at a distance of about 1,000 yards, were fitted to the convoy lights.

Automatic door cut-out switches with the necessary circuits for the control of lights in the chart room and

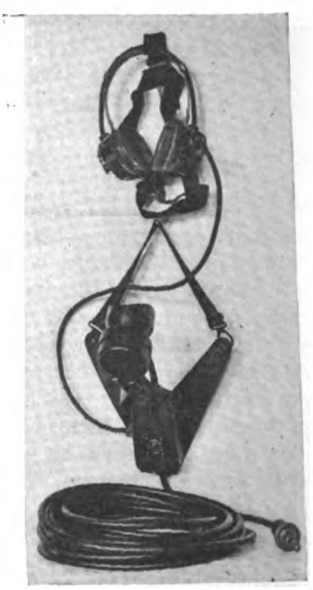

Fig. 8.—Loud Speaking Telephone Equipment

other compartments insured darkness on the weather deck when the ship was running in the danger zone. Where the number of lights in any social hall, wardroom, or other compartment opening on the weather deck, exceeded ten, all doors leading to such compartments had to be equipped with cut-out switches connected in series with the solenoid of an automatic relay.

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A fused switch and distribution panel was arranged in the pilot house for the individual control of the navigating circuits, each switch being provided with a suitable name plate to indicate the light or signal controlled. This panel was fed directly from the main switchboard, and designated as the battle circuit and as such had to be kept ener-

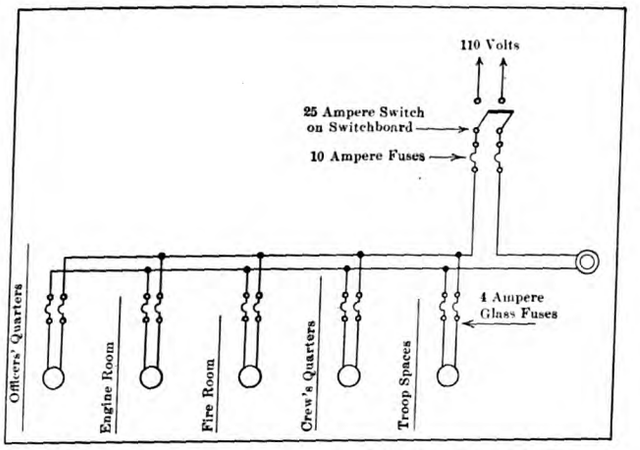

Fig. 9.—Alarm Gong System Installed on Troopships

gized at all times. The following appliances derived power from the navigating circuit panel:

Mast head light.
Towing light.
Port side light.
Starboard side light.
Range light.
Stern light.
Screened stern light.
Convoy light.
Blinker signal set.
Two 12-inch incandescent signalling searchlights.
Man overboard and breakdown lights.

A double-pole, single-throw fused switch installed in the pilot house was provided for de-energizing the navigating circuit panel. The starboard and port lights might also be cut on or off from either side of the bridge by means of switches on each wing. When the ships were running in darkness, it was sometimes necessary to flash a starboard or port side light upon approaching other

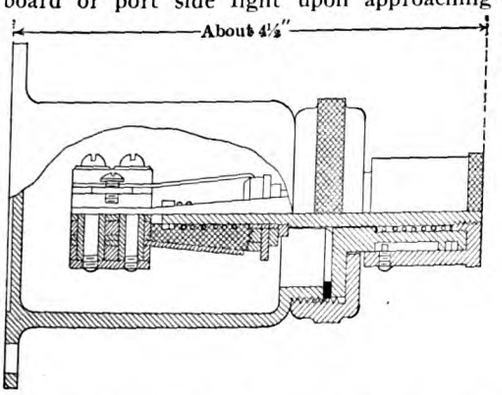

Fig. 10.—Alarm System Contact Located on the Bridge

ships in order to give warning as to the side on which they should pass.

Motor-Driven Equipment

Suitable direct-connected motor-driven ventilation sets (about 20 sets per ship) delivered 100,000 cubic feet of air per minute at a total head of 2.2 inches of water, in addition to the motive-driven ventilation already installed, were required to properly ventilate the troop and crew spaces.

A separate circuit from the main switchboard was installed with outlets on the bridge and lookout stations for foot warmers, each requiring about 200 watts. These were furnished for the purpose of making the officers and men on watch comfortable during the severe winter months.

Ship Telephone Service

Return call bells, paralleling voice tubes between fire-control stations and lookout stations, were included in the equipment in order that the attention of any lookout or fire-control station could be obtained in case a submarine were sighted.

Ship service telephone systems, averaging about 50 lines, were installed on the majority of the larger vessels. Each telephone system consisted of a commercial installation with the exception of the telephones placed in machinery spaces and where exposed to the weather. Here

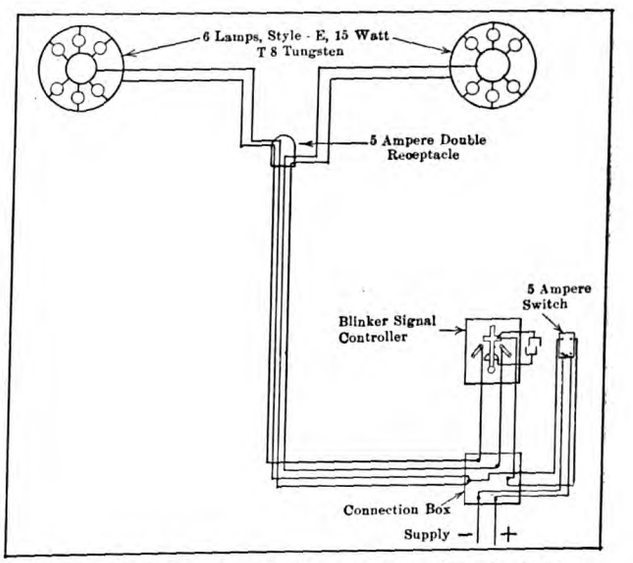
6 Lamps, Style - E, 15 Watt T 8 Tungsten
5 Ampere Double Receptacle
5 Ampere Switch
Blinker Signal Controller
Connection Box
Supply − +

Fig. 11.—Yard Arm Blinker Signals Located on the Bridge

they were protected by means of watertight composition boxes.

The conductors used were of standard lead-covered No. 22 B. and S. gage telephone cable, insulated with two layers of silk and one layer of cotton braid, paraffin treated. Connections from the box or distributing frames to the telephone outlets were made with No. 18 soft-drawn rubber covered, weatherproof, twisted-pair, bridle wire. The conductors in exposed locations were clamped to the bulkheads by means of clips 12 inches apart. Conductors passing through hatches or at other points, subject to mechanical injury, were protected by suitable lengths of proper size conduits. All conductors in ducts or watertight bulkheads had to be made watertight by means of Navy standard stuffing tubes. Each installation after completion was required to withstand a resistance test of 500 megohms.

In order that ships might maintain the required speed and distance in convoy it was necessary to have an engine revolution telegraph system consisting of the round pattern, cast instrument known as the one, two, three faster-and-slower type, Fig. 6.

Due to the desire on the part of the Government to conserve the supply of Navy standard lead and armored cable, 20-conductor, known to the trade as aerial telegraph cable, was used for these installations. This cable was not carried through conduits but made watertight where it passed through compartments and decks by means of stuffing tubes and was protected against me-

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chanical injury at such places by 18-inch lengths of guard tubing. Before going into service, all cable was given a coat of shellac and carefully painted.

Duplicate loud speaking telephone equipments were installed for communication between important stations.

MASTER STATIONS

The master stations for the port and starboard systems, Fig. 7, were located in the forward fire control station side by side so that both systems could be operated by either one or two persons, as desired. Telephones, Fig. 8, were used by the lookouts in connection with alidades for making submarine observations and reporting to the officer in charge at either the forward or after fire control stations. Communication was also established between the forward and aft fire control stations in order that gun fire might be directed from either one. The starboard control panel jack was located in the forward station. This arrangement permitted both the forward group of guns and the after group to be controlled from either or both stations. Energy for the fire control apparatus was supplied by a 20-volt storage battery furnished with a rheostat for charging the battery from the ship's generators.

GENERAL ALARM SYSTEM

A general alarm gong system, Fig. 9, with a contact-maker, Fig. 10, located on the bridge with 6-inch watertight, vibrating gongs energized by the ship's voltage was installed in order that the alarm could be given in case of attack by the enemy.

Warning signal systems, consisting of approved commercial type industrial howlers with contact makers in each fire control station, were located as follows:

One between the forward guns.

One each in the forward and aft gun crew's living quarters.

One aft between the guns.

One between each pair of guns, if more than four were mounted on a vessel. This system was provided so that the gun crews might report at their combat positions before the troop calls caused the decks to become congested with men making their way towards the boats.

Yard arm blinker signals, Fig. 11, with controllers mounted on the bridge, were arranged according to Navy requirements for the purpose of providing mechanical signal arrangements between ships.

On the after mast were the "man overboard" and "breakdown" signal systems consisting of two double lanterns, the upper half of each being fitted with a red lens and the lower half with a white lens. These signals were energized through a switch on the navigating panel in the pilot house and the lights operated by a controller on the bridge.

It was found that the additional electrical equipment installed required an additional distribution panel to adequately care for the circuits. To this end a standard panel was developed and made part of the equipment on each vessel in addition to the ship's main switchboard.

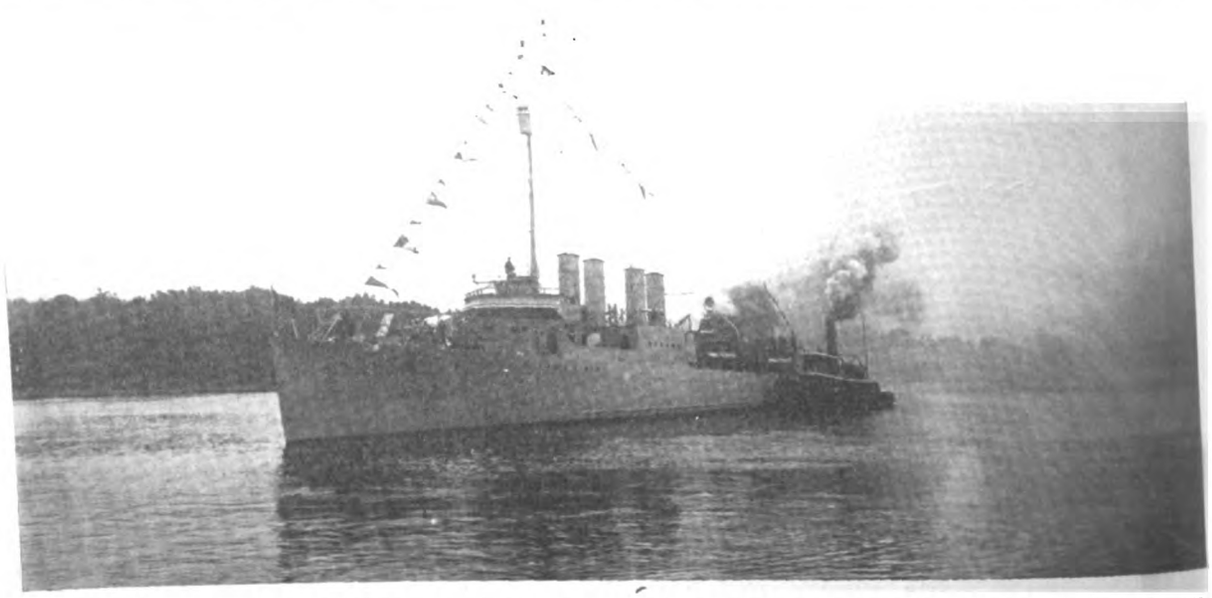
Last of the Destroyers at Fore River Delivered

Thirty-sixth Vessel Just Completed Will Be Flagship of 45th Destroyer Division

THE Quincy works of the Bethlehem Shipbuilding Corporation has completed its war program of thirty-six torpedo boat destroyers for the United States Navy. On September 23, the *Turner* cast off her lines at the yard and started on her short run to the Charlestown Navy Yard, where she was delivered.

Previous to the departure of the *Turner* a mass meeting took place in one of the shops, over which Superintendent Gould of the Quincy plant presided. In reviewing the destroyer program Mr. Gould complimented the workmen for their loyal service in placing the Fore River plant at the head of the shipbuilding industry during the war. Naval Constructor Hilliard called attention to the fact that the completion of thirty-six destroyers in twenty-seven months is a shipyard record which never had been duplicated.

The *Turner* is to go to the Pacific ocean and will be the flagship of the Pacific 45th destroyer division.



The United States Torpedo Boat Destroyer "Turner," La st of 36 Destroyers of Contract Completed by Fore River Plant, Bethlehem Shipbuilding Corporation

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Naval Architects' Annual Meeting

Twent-seventh General Meeting of the Society of Naval Architects and Marine Engineers—Abstracts of Papers Presented and Discussion

THE twenty-seventh general meeting of the Society of Naval Architects and Marine Engineers was opened in the Engineering Societies building, 29 West 39th street, New York City, on Thursday morning, November 13 with Rear Admiral Washington L. Capps, U. S. N., president of the society, in the chair. The secretary-treasurer's annual report was read by Daniel H. Cox and approved.

As a result of the efforts made during the past year to increase the membership of the society, ninety-two new members, 45 associates and 9 juniors were unanimously elected so that the total membership at present is 1,447, as compared with 1,393 on November 1, 1918. The financial report indicates that receipts for the year amounted to $28,329.61 (£5,900). Disbursements of $29,463.17 (£6,050) were made. The resources of the society at the present time amount to $51,028.60 (£10,500).

The following deaths were recorded during the year: Members, Edward P. Bates, Marshall T. Davidson, William D. Dicky, Richard L. Newman, John M. Williamson; associates, Clement A. J. Griscom, Jr., William H. Pleasants, Richard C. Veid.

Election of Officers

The following officers were elected for the terms specified:

Vice-Presidents (for term expiring December 22, 1922)—A. P. Niblack, R. M. Watt, H. D. Goulder, C. P. Wetherbee.

Members of Council (for term expiring December 31, 1922)—R. A. C. Smith, Albert W. Goodrich.

Executive Committee (for term expiring December 31, 1922)—Stevenson Taylor, Andrew Fletcher, W. M. McFarland, F. L. DuBosque, J. W. Powell.

Secretary-Treasurer—Daniel H. Cox.

Committee on Papers—William McFarland, F. L. DuBosque, H. L. Aldrich.

As has been customary in the past a brief review of the progress in the shipbuilding and marine engineering fields was given by the president. Data compiled during the war have not yet been released by the Government so that it was not possible for actual figures to be used. Present conditions were compared with those of three different periods in the past twenty years, as reported in previous transactions of the society.

After the president's address, a list of associate and junior members were elected to higher grades.

The reading and discussion of the papers was then begun, the first paper being read by the acting secretary on account of the absence of the author.

Method of Construction of Concrete Ships

BY R. J. WIG

Abstract

The complete programme of concrete shipbuilding of the Fleet Corporation comprises the construction of fourteen ships of five different types. Two of the ships were considered of experimental character and constructed under contract in private yards. One of 3,000 tons deadweight was designed by the Liberty Shipbuilding Company, Wilmington, N. C. The hull was built by them in a private yard at Brunswick, Ga. The outfitting and installation of machinery was done under contract by the American Shipbuilding Company of Brunswick, Ga. The other ship was of 3,500 tons deadweight and was designed by the Fougner Concrete Shipbuilding Company of New York. The hull was constructed by the designers at Flushing Bay, N. Y., but the outfitting and installation of machinery were done by the Lord Construction Company of Providence, R. I.

The remaining twelve ships were constructed in yards owned by the Emergency Fleet Corporation and especially designed and built for the purpose. The yards were built and operated by contractors who acted as agents for the corporation. Following is a list of the contractors and a statement of the location of the yards and the number and type of ships built.

The San Francisco Shipbuilding Company, operating the yard at Oakland, Cal., is constructing complete two 7,500-ton deadweight concrete oil tankers, and one 7,500-ton deadweight cargo ship. The Pacific Marine and Construction Company is operating the yard at San Diego, Cal. It is constructing complete two 7,500-ton deadweight concrete oil tankers. Fred T. Ley & Company, Inc., of Boston, Mass., is operating the yard at Mobile, Ala., and is constructing complete two 7,500-ton deadweight concrete oil tankers and one 7,500-ton deadweight cargo ship. The A. Bentley & Sons Company, of Toledo, Ohio, is operating the yard at Jacksonville, Fla., and is constructing the concrete hulls for two 7,500-ton deadweight oil tankers. The tankers are being outfitted by the Jacksonville Ship Outfitting Company at Jacksonville, Fla. The Liberty Shipbuilding Company is operating the yard at Wilmington, N. C., and is constructing ten 3,500-ton deadweight concrete hulls. The outfitting is being done by the Jacksonville Ship Outfitting Company.

The author describes in considerable detail the methods of blocking and scaffolding, the construction and use of outside and inside forms, the kind and quality and methods of fabricating and placing reinforcing steel, the materials used for making concrete and methods of placing concrete, together with complete details of launching, painting and outfitting the vessels.

At the time of writing, only the 3,000 and 3,500-ton deadweight experimental concrete ships have made their trial trips. On the trial trip of the *Polias* (3,500-ton deadweight) the log shows that she was run for six hours at full speed, averaging 10.5 nautical miles per hour. Over a 7-mile stretch of this course, the speed was figured at 11.4 nautical miles per hour. At this speed her engines were making 93 revolutions per minute and indicated 1,364½ horsepower. The guaranteed speed of the *Polias* was 10.5 nautical miles per hour.

Both the *Polias* and the *Atlantus* handled very much as a steel ship of similar size and lines, and with the same type engines would handle. The chief difference which was noticed by everyone on the trial boards was the marked lack of vibration on the concrete ship. One other point, which was formed in both concrete ships, is that they backed nearly straight and can be steered slightly while backing.

At the time of writing, total costs are available on the hulls of four 7,500 deadweight ton reinforced concrete oil tankers. The net cost for the hull alone ranges from

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about $600,000 to $700,000. As yet none of the larger ships has been completely outfitted, and no figures are now available as to the final cost of this work. The partial figures now on hand would indicate that the outfitting would cost, including material and labor, about $600,000 for each 7,500-ton ship. The tankers will therefore cost in the neighborhood of $1,250,000 or about $167 per deadweight ton. This figure should be compared with the $225 to $300 per ton cost for steel tankers built during the same period.

The concrete ship, the author claims, is a practical structure and, if properly designed and built, will resist the normal stresses to which ships are exposed at sea. It has, however, one inherent weakness. The 4-inch shell of a concrete ship will not resist local impact of moderate intensity to the same extent as the shell of a steel ship of the same capacity. Up to the present writing, no concrete ships have been exposed to collision or severe impact, therefore the behavior of a concrete ship under such conditions is unknown. As a compensating feature, it has been found that concrete ship hulls are more easily and cheaply repaired than steel ship hulls. On account of this more friable character of the shell of a concrete ship, it is necessary that it be handled more carefully than a steel ship when in harbor. It is possible some means will be found to obviate this weakness.

The future utility of the concrete ship depends upon two factors—one, its durability, and the other is economy of operation as compared with wood and steel ships. The final durability of the concrete ship can only be determined by years of experience, but it is quite probable that two or three years of operation of the ships now building will furnish some indication of the life which may be anticipated.

When the concrete ship has demonstrated its durability, many situations will be found where it will prove more economical than either wood or steel in spite of its greater hull weight, which probably can never be entirely overcome.

Discussion

Alfred J. C. Robertson stated that when every shipyard was working hardest and the steel plants busiest the concrete ship was produced to fill an immediate need for tonnage. The first work in this construction certainly was open to criticism but developments that have been made in concrete ships subsequently deserve an unbiased test.

Certain statements made in the paper on freeboard and displacement ratios for concrete ships are a little too optimistic when tested under actual conditions but these figures and other minor matters will be corrected by the author before the proceedings are finally published.

The first concrete ship, *Faith,* was more or less of a failure, although even after several months in the water her hull has not shown deterioration. However, the concrete ship and its possibilities should by no means be condemned because of the failure of this vessel to meet all her requirements.

Development of Shipyards in the United States During the Great War

BY CAPTAIN R. E. BAKENHUS, C. E. C., U. S. N.

Abstract

In 1912-1913 there were in the United States 49 shipbuilding yards with an estimated number of 184 ways. Of these yards 25 were on the Atlantic coast, 8 on the Pacific coast, 16 on the Great Lakes, and none on the Gulf. Early in 1917, before the United States declared war on Germany, the number of shipyards had increased to 132, with approximately 419 ways. Of these yards 66 were on the Atlantic coast, 32 on the Pacific coast, 27 on the Great Lakes, and 7 on the Gulf coast. By the fall of 1918—that is, before the armistice was signed and before any of the war yards were dismantled—the number had increased to a total of 243 yards, with approximately 1,202 ways, of which yards 117 were on the Atlantic coast, 64 yards were on the Pacific coast, 29 yards were on the Great Lakes, 32 yards were on the Gulf coast, with 1 inland yard on the Cumberland River in Tennessee, with two ways. These numbers include yards in which the Emergency Fleet Corporation had no interests, as well as those in which the corporation's vessels were built.

The total approximate estimated value of all the various yards engaged in building ships for the Emergency Fleet Corporation is $369,125,000; of this sum, the amount furnished from Emergency Fleet Corporation funds is approximately $220,973,000. It is impossible to estimate at this time the returns to the Fleet Corporation from the sale and salvaging of the various properties in which it has invested capital.

A careful examination of the data which has so far been prepared indicates very little uniformity in the extent of equipment provided for the various yards. Even in the yards of greatest efficiency, as indicated by their output, there is very little uniformity. This leads to the conclusion that the efficiency of a shipyard is less dependent upon plant layout than upon other factors, the principal one of which is, of course, the personnel. There is no doubt, however, that while plant layout is not the most important factor, it is nevertheless one of great importance in the establishment of a building yard. The study of a relation of plant layout to efficiency in plant output has not been contemplated in time to be outlined in this paper. It is therefore not safe to draw any conclusions at this time as to the exact function of plant layout in determining efficiency.

Steel Ship Construction From a Management Viewpoint

BY CREIGHTON CHURCHILL

Abstract

Published records show 21,800,000 deadweight tons of shipping lost since the beginning of the war, during which time 15,700,000 tons were constructed, making a net loss of 6,100,000 deadweight tons. The rate of construction for five years prior to the war was 2,300,000 tons per year, which, it is anticipated, will become about 5,000,000 tons per year until 1924 or 1925, when the rate of construction will become a matter of replacement and natural increase due to trade expansion, probably somewhere in the neighborhood of 3,000,000 tons a year. Naturally a very large percentage of this will be steel construction.

As of April, 1919, there were sixty-seven yards in the country with 425 ways capable of building steel ships of over 3,000 deadweight tons. There were under construction at these yards 637 steel vessels aggregating 4,225,000 deadweight tons, and 591 vessels, aggregating 4,200,000 deadweight tons, yet to be constructed. In the country alone, therefore, provision has been made to add some 8,425,000 tons to the world's shipping with a total yearly output of approximately 3,000,000 to 4,000,000 tons, depending on the type of ship. It is apparent, therefore, that it will take about two years to complete the present program, provided it was spread over the entire industry. This, however, is not the case, and it is estimated that at the close of the present year from 30 percent to 50 percent of the country's capacity will be avail-

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for contracts for private account. In other words, a capacity of from 1,000,000 to 2,000,000 tons a year will be released, and it is tonnage to this amount that must be built to meet immediate demands and at the present prices of material and labor. If this business can be secured, it is the writer's firm belief that the shipbuilders of this country will find the means to develop the industry along modern lines such that its future will be assured.

During the war, time was the very essence of all contracts, with expense a less than secondary consideration. With conditions reversed and a reasonable time to adjust themselves on a strictly economical basis shipbuilders will continue in business only so long as they pay strict attention to factors under their control. A cursory analysis of the situation indicates that the factors under direct control of the shipbuilders are organization, management, method, and, to a greater or less extent, men. The prevailing market controls both material and wages, the latter through labor being considered a commodity, but as it is extremely doubtful if the market will continue to exercise its former control on wages, the element of wages is treated in this paper as one of the factors not under control by the shipbuilder.

It is a foregone conclusion, other things being equal, that the success of an industry is very largely a matter of organization and management. Assuming that the organization, management and methods fulfil requirements, the only remaining factor under control is the men. On this factor hinges final costs after defects in the other factors under control have been remedied. It may be of interest to know that the results of analytical studies of operations in over 50 percent of the steel yards engaged on construction for the Emergency Fleet Corporation during the war indicate that less than 20 percent of the faults developed were chargeable to the men. This is simply another way of saying that other factors under control were responsible for some 80 percent. Accepting this statement as correct, it will be shown that the combined result of reducing the faults of both men and management is a very material reduction in construction costs. In fact, the practicability of so doing is what confirms the writer in his belief that the shipbuilding industry will have itself to blame if it cannot stand on its own feet in the face of foreign competition.

In investigating the costs of ships of different types and cargo carrying capacity an intimate relation developed between fabricating capacity, number of ways, construction program and man efficiency, the last expressed in deadweight tons of output per man per year based on the entire force engaged on ship construction, exclusive of office force and men engaged on plant construction. A 7,500 deadweight cargo vessel was used in the calculations, with material costs as follows:

Hull, $212,952 (plates at 3¼c.; shapes at 3c.; bars at 2.9c.).

Machinery, $266,515 (2,899 horsepower reciprocating engines; three 13-foot by 12-foot Scotch boilers).

Equipment, $104,371 (military requirements, $30,000).

The labor cost was calculated on the basis of man efficiency, using $5.40 as the average daily wage of all men engaged on ship construction. To arrive at the number of men per way the following formula was used:

$$\text{Men per way} = \frac{300 \times a}{b \times c}$$

in which

a = fabricating capacity per 8-hour day.

b = tons steel erected per man per year.

c = number of ways.

300 = number of working days per year.

Launching was assumed when 90 percent of the steel was erected and riveted. A balance between fabricating, erecting and riveting was taken for granted.

A careful study of the data presented in the paper develops some very interesting results which may be expressed as laws and enumerated as follows:

1. For a given man efficiency there are a certain definite number of ways and a certain building program that will result in minimum costs.

2. As man efficiency increases costs decrease according to a diminishing ratio and not in direct proportion to increase of efficiency.

3. The lower the man efficiency the greater the number of ways and the longer the building program to secure most economical construction.

The intimate connection between man efficiency and building program show, beyond any question, the advisability of working to standards and setting such standards within reach of the working force. For example, if a contract were secured for delivery of a 7,500 deadweight ton cargo vessel in 155 days from keel laying (125 days keel to launching and 30 days launching to delivery), there is a possible variation in cost of about $117 and $158 per deadweight ton, depending on whether the yard can show a man efficiency of 65 deadweight tons or 25 deadweight tons per man per year with a fabricating capacity of 90 tons per 8-hour day. Obviously this difference is entirely a matter of labor cost and shows the necessity of paying all possible attention to man efficiency and making every effort to bring it up to a standard. It is suggested that standards be set in accordance with the following table which represents actual performance on cargo ships in going yards for an equivalent period of 120 months:

Deadweight Tonnage	Standard per man year	Values of *b*
3,500	30 deadweight tons	10
5,000	36 deadweight tons	12
7,500	45 deadweight tons	16
10,000	53.5 deadweight tons	20
12,000	61 deadweight tons	23

The values of "*b*" corresponding to the different man standards for ships of different tonnage is included in the above table because it is the basis for figuring the number of men per way to attain the given standard. (The values of "*b*" listed were derived from actual performance in twenty-three yards. Of these yards 37 percent manufactured engines and boilers, 32 percent either engines or boilers and the balance, 32 percent, neither engines nor boilers. This is mentioned that proper allowance may be made in the use of the formula for individual yards.)

Ship construction depends primarily on a balance being maintained between fabricating, erecting and riveting, with outfitting and machinery installation depending on the progress of these three elements. That the standards set may be used to best advantage, charts are suggested as a form for presenting performance to the men. The charts are based on building 7,500 deadweight ton cargo vessels in a five-way yard with 150 tons fabricating capacity on a predetermined 75-30 building program. Average daily performance by weeks is shown graphically, while figures are used to show this average to date. As drawn up, these graphs are intended for use by the general superintendent and the general foremen responible for the different activities. For the information of the men the same general idea can be followed out with such changes as may seem desirable. It is suggested that, for

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this purpose, daily performance be used in connection with blackboards at each way and in the fabricating shops.

As a final example of the necessity of giving consideration to all the elements involved in shipbuilding, curves were developed as indicative of what happens in actual practice. A five-way yard was taken with a man efficiency of 35 equivalent deadweight ton per man per year. The problem is treated from two points of view, namely:

1. Constructing cargo vessels of different deadweight tonnage on a fixed 100-30 building program.

2. Constructing cargo vessels of different tonnages at a fixed fabricating capacity.

It is evident that a fixed building program involves different fabricating capacities and number of men per way for ships of different tonnage, while, with a fixed fabricating capacity, the men per way remain the same but the building program varies. That a proper comparison between these two conditions might be made, it was assumed that the yard was organized and equipped to build 5,000 deadweight ton ships on a 100-30 building program.

The conclusions to be drawn from a study of the curves presented show, beyond any question of doubt, that construction costs are dependent to a very large extent on tonnage, and, consequently, that each individual yard should confine itself to vessels that come within its field. Just what the field of any yard might be is determined from the most economical building program at a given man efficiency for ships of different tonnage. For a 7,500 deadweight ton cargo ship the most economical building program is 113-30 at a man efficiency of 35 deadweight tons. Corresponding to this program, the fabricating capacity should be 100 tons. The number of ways corresponding to the above would be five, consequently a five-way yard with 100 tons fabricating capacity would be in a better position to build a 7,500 deadweight ton cargo vessel than a yard differently equipped. Conversely, by the same method, the field of a yard can be determined, always keeping in mind the man efficiency. While a standard man efficiency of 45 equivalent deadweight tons* has been offered as a result of actual performance it is suggested that, in yards that do not come up to this standard, a tentative one of 35 equivalent deadweight tons be set up to work to. Unless this is done, it is not possible to figure definitely on results to be accomplished nor keep in close touch with day to day performance.

DISCUSSION

Professor H. C. Sadler, who was associated in the work with Creighton Churchill, brought out the fact that this paper represented a complete study of all the data compiled on shipyard management during the war.

It has always been thought that to increase production in the shipyards it was necessary to increase the number of shipyards, increase their capacities and build new ways. As a matter of fact, however, the man power in a yard and its operating efficiency combine to influence the actual tonnage output. In the paper, Figs. 3 and 4 particularly give the actual cost per deadweight ton plotted as abscissae and the deadweight tons per man per year produced as ordinates for yards having a various number of ways. This question of the number of ways proves to be most important in studying the curves for in a five-way yard the cost per deadweight ton is less than in a ten-way yard.

Costs in the shipyards vary between $117 and $158 per deadweight ton depending on whether the yard shows a man efficiency of 65 deadweight tons or 25 deadweight tons per man per year. The greatest factor in this is of course labor cost, depending on man efficiency. If the nation is to compete with the powers of the world in shipbuilding production, costs must be reduced and this paper, if studied carefully, indicates various means of reducing production costs in competition.

In plotting the curves any shipyard can substitute figures representing local conditions and a check can thus be kept on production.

President Capps requested information on the relation between man efficiency and overhead cost, as mentioned in the paper. For the information of the members, Creighton Churchill based his conclusions on weekly and monthly reports of the Emergency Fleet Corporation which cover every yard in the country engaged in Government construction.

Data were separated into three divisions, coming under the head of plant construction, ship construction, repair and other work. The number of men engaged in all of these represented the actual number of men required to produce ships directly or indirectly. From the individual yard records of deadweight tonnage it was possible to arrive at the output in deadweight tons per man per year for the total number engaged in shipbuilding.

In arriving at the overhead costs to be charged against ships, it was found that 20 percent of the overhead was due to inefficiency of man power and 80 percent due to lack of control and organization. The cost of training men helped accumulate the 20 percent overhead from the first cost, while the cost of raw materials, inefficiencies in production, the losses due to the inexperience of the organization in shipbuilding all combined to produce the second factor in overhead. Labor inefficiencies maintained an average overhead cost per ship per day of $1,000. In general, the smaller the yard with a trained personnel, the more efficient production became.

Under normal conditions, the question of overhead will adjust itself so that the actual figures under stress of war conditions only serve as an arbitrary basis for future comparisons.

An Analysis of the Isherwood System of Ship Construction

BY JOHN FLODIN

(This paper will be published in an early issue.)

DISCUSSION

John C. Reid in discussing this paper brought out the fact that the Isherwood system of ship construction had saved steel without lessening the strength of the ship. After an order for a ship has been given, its scantlings can be determined within twenty-four hours so that steel might be ordered immediately. For this reason, during the war, when the time element entered into every transaction, the system received a great impetus, and rightly so.

It can be used in a great many different types of ship and has the advantage of being very easily repaired in case of accident. On the Great Lakes, however, where a ship is subjected to scraping on the bottom, and in the canals, where she may be liable to rub the banks and locks, it has disadvantages because of long scores between the longitudinals. Passenger steamers have sufficient strength in their structures because of the number of decks, as well as double skins without the use of the system.

As an example of the strength of this structure, reference was made to the *Storstad* and *Empress of Ireland* collision, in which the *Storstad* rammed the *Empress of Ireland* at an angle of about 48 degrees and, glancing past, cut a 4-foot hole through all the decks of the passenger ship while the *Storstad* was damaged only about

* The term "equivalent deadweight ton" means performance referred to a 7,500 deadweight-ton cargo vessel as a standard for comparison.

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12 feet of her length from the bow aft not quite to the forward collision bulkhead. In repairing the *Storstad* the acetylene torch was used to cut off the damaged section after which a new bow was put on in a very short time.

The fact that great caution must be exercised in longitudinally-framed ships to insure sufficient strength in torsion was brought out by Elmer A. Sperry. The tendency in the design of cargo ships has been to neglect the stiffness factor where large hatches have been cut into the deck.

The strength of a tube in torsion is very well known. When a tube is subjected to twist practically no distorsion is noticed in its entire length. If the tube is cut longitudinally, two gutters result. The ratio of torsion between the tube and the gutter is about 36,00 1. A ship although not exactly a gutter, according to Mr. Sperry, approaches it, if great strength is not supplied in the deck structure. The torsion exerted by wave action must be taken care of some way, and he claimed that the Isherwood system does this. Incidentally, a great amount of weight is saved in the use of this system.

THURSDAY AFTERNOON SESSION

Economical Cargo Ships

BY ALFRED J. C. ROBERTSON

(This paper is published on page 799.)

DISCUSSION

According to Professor H. C. Sadler this paper will prove of great value in producing cargo ships of the future for it is possible by substituting data from various plant records to arrive at the most economical ship sizes and powers to be used with a given design. The paper justifies the type of cargo carrying vessel used by the Emergency Fleet Corporation which is of the 8,800-ton type having a speed of about 10 knots. It has been estimated that the size of a ship alone determined its economy and that the larger vessels were more efficient. Plate 2, Fig. 6, however, in which ships' speeds are plotted against the deadweight tonnage moved per year for ships of varying lengths and speeds, shows that a 350-foot ship at a 10-knot speed has a greater annual carrying capacity than a 500-foot ship at the same speed.

The value of model experiments in ship design are not always given the credit due them and if they were followed a little more exactly, ships of superior design would certainly result. A week or two is usually required to produce the lines and calculations necessary to build a model. After the model has been tested for speed and performance in general, the material for the ship has already been ordered, and, although in many cases eight or ten percent of the power of a vessel might be saved by varying the design according to discoveries made from the model, progress on the ship has advanced too far for such changes to be incorporated.

The model will aid, if its performance is carefully followed, in producing the best ship for a given speed.

E. H. Rigg, naval architect of the New York Shipbuilding Corporation, commended this paper particularly to shipowners and operators, pointing out that many times an inquiry for a ship is based on some such analysis as given by Robertson in this paper or by Anderson, Urwin, Baker, Kent and Donald in similar papers read before sister societies in Britain. Other investigations covering the economics of still larger vessels are available, notably by Sir John Biles and Lord Pirrie, also by the Canadian Royal Commission on Overseas Communications.

Referring to line 36, Plate 1, Mr. Rigg called attention to the statement that the cost of manning and management is the same for each speed of any given length of ship. With horsepower for 13 knots practically double that of 10 it is difficult to see why engine room manning costs were not increased with speed. For double power about a 35 percent to 40 percent increase in engine room salaries and wages would appear to be in order. He believed that the idea of first stating the figures for the actual ship and then reducing them to a basis of each $1,000,000 invested will appeal to the operator and investor at once.

Fig. 3, Plate 2, gives a diagram of dwindling profits as speed goes up. It will be of interest to take this another way; that is, increase the freight rate to maintain equal profits as at 10 knots. These figures refer to the 3,500-mile voyage and minimum port detention, oil fuel at $6.00 and tonnage dues at $1.50.

TABLE OF GROSS FREIGHT RATES

Length of Vessel in Feet	Speed of Ship in Knots 10	11	12	13
350	$6.00	$6.33	$6.87	$7.82
400	6.00	6.27	6.71	7.32
450	6.00	6.24	6.57	7.08
500	6.00	6.25	6.54	6.98

This table shows clearly the advantage of the large ship at the higher speeds, the 500 feet ship can take freight at 84 cents per ton cheaper than the 350 feet at 13 knots. Still another interesting comparison is to take a fixed gross annual profit of $200,000 per million invested for all ships and see how the freight rates compare. This table works out as follows:

TABLE OF GROSS FREIGHT RATES

Length of Vessel in Feet	Speed of Ship in Knots 10	11	12	13
350	$5.91	$6.24	$6.78	$7.70
400	5.71	5.97	6.38	6.95
450	5.67	5.89	6.20	6.68
500	5.61	5.84	6.11	6.51

This table shows that a 10-knot vessel can always underbid the faster, other things being equal; it also shows that the 450-foot ship at 11 knots can underbid the 350-foot ship at 10 knots. This is another confirmation that the tendency to run at 11 to 11½ knots in the larger freight vessels is sound. The penalty paid for high speed in small ships is again brought out.

Mr. Robertson does well to direct attention to the painful results of undue detention in port. This again emphasizes adequate handling gear and terminal facilities as a necessary accompaniment to successful operation.

Non-Rolling Passenger Liners — Observations on a Large Stabilized Ship in Service, Including the Plant and Economies Effected by Stabilization

BY ELMER A. SPERRY

(This paper will be published in an early issue.)

Submarines in General—German Submarines in Particular

BY COMMANDER E. S. LAND, CONSTRUCTION CORPS, U. S. N.

ABSTRACT

Prior to the war, the opinion was prevalent that the submarine was essentially a defensive weapon and of little value as an offensive weapon. The facts revealed by the war have changed this opinion since the submarine has so efficiently proved its worth as a very powerful offensive weapon. Its ability as a scout was truly marvelous, as it was able to gain a maximum of information at a minimum of expense.

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Among the things accomplished by the submarine one fact stands out as particularly noteworthy, namely, that more men-of-war were destroyed by submarines than by any other type of war craft. Likewise the submarines proved their efficiency in being the most effective means for watching the movements of the German fleet; in fact, much of the information obtained regarding the activities of German war craft was obtained by submarines on picket and patrol duty; furthermore, few movements of German war craft escaped their vigilance.

During the war, the British maintained a picket line with their submarines inside Heligoland Bight. This proved to be an extremely dangerous post to maintain, and the picket line was later withdrawn outside of Heligoland. The British lost six submarines in six weeks during one period of picket duty inside Heligoland; during the entire war they lost twenty-nine out of fifty-eight of their "E" class of boats. Owing to the very dangerous duty performed, it was considered that the normal life for these picket boats was twelve patrols, yet the "waiting list" at Harwich was the longest; this proves the metal of the British Submarine Navy.

The Germans had about thirty submarines at the beginning of the war; during the four and one-half years following they produced or had in process of construction at least six hundred and fifty more, making a total of approximately six hundred and seventy. Of these, two hundred and three were lost during the war. The number of allied craft engaged against the German submarines was in the approximate ratio of 200 to 1.

The German submarines destroyed about 15,000,000 tons of shipping and killed about 16,000 people during the war. During the last three months of the war they destroyed about 1,000,000 tons. It was only in October, 1918, that the construction of allied vessels covered the current losses caused by the German submarines.

In concluding my paper on "Submarine Hulls" presented to the Society in 1917, I ventured two predictions. One was that the great preponderance of submarine construction was in the vicinity of 800-ton vessels. This is well borne out by a study of the designs laid down during the war, some of which are still under construction. The other prediction was that the submarine itself is the best antidote for the submarine. Anyone who will analyze in detail the number of submarines lost in the war will find that, due consideration being given to the relative number of vessels engaged in anti-submarine warfare, the allied submarines accounted for more enemy submarines than any other type of vessel.

GERMAN SUBMARINES

It was the writer's privilege to be detailed as a member of the Naval Allied Armistice Commission which proceeded to Germany in December, 1918, on board the H. M. S. *Hercules*. It also fell to my lot to be detailed as a member of the American Submarine Inspection Board which inspected German submarines after their surrender at Harwich, England. A casual inspection of about one hundred submarines and a detailed inspection of one vessel of each type were made.

All modern German submarines are of the double-hull type. The war produced three standard types of German submarines which are known as the UC type, the UB type and the U boat or "mittel U-boat." In addition to the standard types, there were two special types, as follows: UE type, mine-laying cruisers; UA type, large cruiser class. The large cruiser class consists of two designs, the ordinary design being a vessel of about 2,000 tons surface displacement, while there were a few of the special cruiser design of about 1,200 tons surface displacement. There were apparently only two vessels in this class completed, and they were especially designed for surface speed.

The UC class is made up of small, coastal, mine-laying submarines. This class has a surface displacement of about 500 tons and a submerged displacement of about 575 tons. These vessels in their latest development are about 185 feet long, 18 feet beam, and 12 feet draft. They made about 11½ to 12 knots on the surface and 6 to 7½ knots submerged. The mines were carried in the forward part of the vessel in non-watertight compartments or mine wells, 18 mines being usually carried, although some of the designs carried only 12. A torpedo tube was fitted in the stern and two torpedo tubes were fitted externally in the superstructure, sometimes forward and sometimes abaft the conning-tower. They usually carried one 10.5 or one 8.8-cm. gun. There were about 100 of these boats completed and a great many more in the course of construction.

The UB class of vessels formed the coastal submarines and were vessels of about 520 tons surface displacement and 650 tons submerged. They were 183 feet long, 19 feet beam and 12 feet draft. They had a surface speed of about 13½ knots and a submerged speed of 7½ to 8 knots. Four torpedo tubes were installed in the bow and one in the stern. They usually carried one 10.5-cm. gun; no mines were carried on the UB class.

It is of particular interest to note that the UB class and the UC class in the final analysis were very similar in size and displacement. An examination of the boats of these classes in Germany in December, 1918, showed very completely the progressive steps made in the design and construction of these types of vessels. The earlier UB boats and the UC boats only displaced about 125 to 150 tons each. It was very soon demonstrated that these boats were too small for the purpose intended and when standardization took place it resulted in boats as indicated above. There were about 140 UB boats completed and many more under construction at the time the armistice was signed.

U-boat—"Mittel U-boats."—The first boat of this class was completed in 1906 and had a surface displacement of 238 tons. The increase in the size of this type of submarine continued through various progressive stages until 1914, when the displacement had reached about 760 tons. The "mittel U-boats" subsequent to this date were generally similar in design except that the displacement increased slightly so that the latest type had a surface displacement of about 830 tons. The standard design of "mittel U-boats" has about the following characteristics:

Surface displacement	830 tons.
Submerged displacement	1,030 tons.
Length	235 feet.
Beam	20½ feet.
Draft	12½ feet.

Designed surface speed, about 16 knots.
Actual surface speed, about 15 knots.
Designed submerged speed, about 8½ knots.
Actual submerged speed, about 8 knots or less.

Most of the "mittel U-boats" were fitted with four bow torpedo tubes and two stern torpedo tubes. They carried either one or two 4.1-inch guns. This type of boat was considered the most successful of the German submarines, and many of the German service consider that, if they had adhered to this type of vessel, they would have been more successful in their submarine warfare. The Germans had completed at the time of the armistice about 110 of these vessels; a large number were also under construction in various parts of Germany.

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UE Class.—These were large ocean-going mine-laying cruisers of:

Surface displacement	about 1,200 tons.
Submerged displacement	1,520 tons.
Length	275 feet.
Beam	24 feet.
Draft	13 feet.

Designed surface speed, 14.7 knots.
Designed submerged speed, 7.2 knots.
Armament, 4 bow torpedo tubes; 2 stern *mine* tubes, 39 inches in diameter.

Stowage space was available for 42 mines and 24 torpedoes. It is doubtful whether these vessels carried this number of spares. Their gun armament consisted of one 5.9-inch gun and one 4.1-inch, although in some cases they may have carried two 5.9-inch guns. Usually only one gun was carried.

There were about 10 of this class completed and a large number building. U-71-80 were small mine-laying submarines of this general type but of an earlier design, and only displaced about 760 tons. They were not a successful design.

Cruiser Class—UA Type.—Of the special cruiser class there appear to have been completed only 2 boats—U-135 and 136. Their displacement is similar to the mine-laying cruiser class, that is:

Surface displacement	1,200 tons.
Submerged displacement	1,535 tons.
Length	275 feet.
Beam	24½ feet.
Draft	13 feet.
Designed surface speed	18 knots.
Designed submerged speed	8.2 knots.

They had 4 bow tubes and 2 stern tubes and carried one 5.9-inch gun.

The large cruiser class consisted of vessels of the following characteristics:

Surface displacement	about 2,000 tons.
Submerged displacement	2,500 tons.
Length	302 feet.
Beam	29½ feet.
Draft	17 feet.

They carried 4 bow tubes, 2 stern tubes and 19 torpedoes. They had a designed surface speed of 15.8 knots and a designed submerged speed of 7.7 knots. Only four of these boats were actually completed at the time of the armistice, but there were a large number under construction in various parts of Germany.

After describing in detail various features in the design of these vessels the author enumerates the outstanding important features as follows: Excellent engines, excellent periscopes, double-hull protection, large surface radius of action.

A few of the objectionable features and defects are briefly enumerated in the following:

1. No effort made to insulate auxiliaries.
2. Apparently little effort made to eliminate noise of auxiliaries.
3. Elaborate ventilation and cross connections.
4. Elaborate air purifying installations. Altogether too elaborate.
5. Superabundance of shafting running from control room.
6. Bulkheads penetrated by myriads of leads of all kinds.
7. Only one hatch in U. C. conning tower—an element of weakness.
8. Batteries are inaccessible except in UE and UA classes.
9. Folding wireless masts—heavy, awkward, and cumbersome installation.
10. Many emergency leads and connections of all kinds. Altogether too many.
11. Much space given up to officers' quarters and C. P. O.'s; not much space or comfort for crews.
12. Little attention paid to hull excrescences.
13. Submerged speed considered of minor importance.
14. Boats are not well designed as to exterior of hull, so far as speed is concerned, either surface or submerged.
15. With the horsepower the engines give, greater speeds should and could be obtained.
16. Boats are crowded, congested, complicated and filled with "Gadgets" of all kinds.
17. There is a good deal of doubt about the stability of the mine-laying cruisers, and the large cruisers, particularly submerged stability. Ample evidence was obtained to show that the Germans considered this a very serious question with regard to these boats and various modifications and alterations were under way to improve the stability of these designs.

DISCUSSION

President Capps remarked that at the 1898 meeting of the society, when reference was made to the future utility of the torpedo boat and submarine, little did the members realize that in a future war period of two years more than 15,000,000 tons of shipping would be lost due to the activity of the submarine. The submarine certainly has a place now and in the future. It is just as interesting to note that the torpedo boat, which has evolved into the torpedo boat destroyer, has been one of the greatest factors in bringing the submarine warfare to a close in the last months of the war. The great number of destroyers that were produced, their speed, maneuvering qualities and the ability to carry quantities of high explosive served to bring about this desirable end. It almost seems that the end of the big surface battleship is at hand unless the proposed League of Nations eliminates the submarine as the future weapon of war.

FRIDAY MORNING SESSION

The Propulsive Efficiency of Single Screw Cargo Ships

BY COMMANDER WILLIAM M'ENTEE, U. S. N.

(This paper is published on page 796)

DISCUSSION

Alfred J. C. Robertson stated that in Commander McEntee's work of last year a ship having a parallel middle body near the bow was tested, giving the horsepower needed by the ship and the resistance that had to be overcome. With a blunt bow and full stern the greatest propeller efficiency was obtained at a speed of about 6 knots. As the speeds become higher the parallel middle body is moved aft in order that the wave-making resistance and the wake factor shall balance each other.

An increase of 3 percent resistance has been noticed in the changes of this year's model. A vessel having a prismatic coefficient of .80 would be rather full forward for good efficiency. If the fullness were aft, a coefficient of .70 would result. An ordinary ship of good proportions with a coefficient of .61 should give the best results. About 5 percent of the effective horsepower of the model should be added to the shaft horsepower of the full-sized ship as computed from the model to overcome the resistance of the bilges and the wind-making resistance.

It would be interesting, stated W. L. R. Emmet, to compare the series of tests conducted by the General Electric Company's men on a tank steamer. Data were compiled from readings made on a torsion device which

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connected the shaft to the propeller by means of a system of springs and twist amplifying devices. With the apparatus a complete record of stresses in the shaft under working conditions in all kinds of weather were possible.

Turbine speeds were computed from the torque and under a 4-degree pitch of the vessel the torque nearly doubled, indicating that a load was thrown on to the propelling machinery. The propeller was at all times submerged so that the stresses were due to the speed of the propeller and the water. The maximum effect was not due to cavitation but occurred when the propeller was settling into the sea at which time the speed of the water traveling by the ship's side was reduced somewhat. There is no doubt that this action has been responsible for the destruction of turbine gears.

These observations would tend to indicate that a propeller having a large area has the least slip when turning at slow speed. This type would be efficient in rough water while a small high-speed propeller would be most efficient in smooth water.

Buoyancy and Stability of Troop Transports

BY PROFESSOR WILLIAM HOVGAARD

(This paper will be published in an early issue.)

DISCUSSION

W. H. Mackay remarked that when ships were turned over to the Department for conversion into troop transports, it was not possible to make stability calculations. The lines for the ships were not available and it was not convenient to carry out inclining experiments. It was vitally important, however, that the maximum live load should be known and the deadweight ballast necessary to allow for troop carrying.

In the case of the *Leviathan,* it was decided that on her first voyage it would be safe to carry 7,500 troops, 500 officers and 1,500 men in the crew. Anti-rolling tanks were only used during the time this vessel was in service as a transport. It was determined after the first voyage that 12,500 troops could be carried safely and the Navy personnel could be increased to 2,500 men. Later this number was increased by two or three thousand troops.

Rear Admiral D. W. Taylor, U. S. N., chief constructor of the United States Navy, pointed out that to the naval architect of the present day, given the plans of a ship, the position of her center of gravity, and plenty of time, solutions of questions of buoyancy and stability are easy, but that in the stress of the war as a usual thing there were no plans, and no time. A former German vessel between 500 and 600 feet was to be fitted at a yard to carry the maximum number of troops, this vessel must sail the moment she was fitted, and in the meantime the damage done the machinery by her former owners had to be made good. Three things were done as a rule:

First.—Structural additions helpful to buoyancy and stability that could be completed within the time and with the facilities available were made.

Second.—Holes were cut in longitudinal bulkheads to render it reasonably certain that if a transport were sunk by a submarine she would not first capsize.

Third.—Fixed ballast was added as necessary, such that, combined with the available water ballast, acceptable metacentric heights were obtained as explained in the paper.

It was recognized that it was not practicable, without inadmissible delay, to bring up the transports to the plane of safety against torpedo attack of a battleship, and that the main responsibility for safety of our transports rested upon our destroyers and other convoying vessels. These gave a very thorough illustration of Farragut's maxim, that the best defense is a vigorous offense, and no eastbound troop-laden transport convoyed by our Navy was touched by a torpedo. The *President Lincoln,* westbound, was hit by three torpedoes, rendering her sinking inevitable, but she did not capsize. Neither did the *Covington,* which remained afloat a night and the better part of the day after being torpedoed. The *Mount Vernon* was hit at about the worst possible place, at the worst possible time—so far as loss of life was concerned—just as watches were being changed. She returned safely to port, as did the *Finland.*

The Application of Standardization and Graphical Methods to the Design of Cylindrical Return Tubular Boilers

BY HENRY C. E. MEYER

(This paper will be published in an early issue.)

DISCUSSION

E. A. Stevens stated that ships' boilers have been ruined by crowding in too many tubes in order to increase heating surface. After getting scaled the heating surface is decreased unless steps are taken to clean between the tubes properly.

In reply to a request as to the pitch determination for use in the paper, H. C. E. Meyer stated that pitch was based on the standard distance between tubes of one inch vertically and 1¼ inches horizontally. Instances have occurred in which to increase the heating surfaces pitch distances of only $\frac{3}{16}$-inch and ½-inch have been used but the practice is to be condemned both from the viewpoint of circulation and cleaning.

The weight curves for boilers and for water have been based on values taken from 300 different boilers and these weights are correct within one or two percent.

There is a great deal in favor, as was brought out in the discussion, of spacing tubes 7 inches to 9 inches apart over the center of the furnace instead of 3½ inches. A better circulation will result from this spacing.

New Developments in High Vacuum Apparatus

BY G. L. E. KOTHNY

ABSTRACT

The adoption of the steam turbine for marine propulsion has brought about many changes in marine engineering, which have become necessary in order to fully realize the many economical advantages obtainable. These changes affected particularly the vacuum producing apparatus. Steam turbines require the highest possible vacuum for highest efficiency and economy. The importance of this has been realized, and considerable research work has been carried out and many developments have been made in relation to the condensation of steam and the extraction of air. In this paper the author records some developments which have been made during the last few years in the extraction of air from marine condensers, with special reference to the development of the steam air ejector.

After briefly indicating the principles of operation, as well as the most important factors in steam air ejector design, several types of ejectors are described which have been in successful operation in marine condenser installations over two years and thereby have proved their fitness for marine service. Only two types in a variety of sizes have so far been used in a large fleet of merchant marine and navy vessels. These are known as the "Radojet" and the Le Blanc air ejector. Both are of the two-stage type, the stages being connected in series.

Until the appearance on the market of the steam air ejector the twin-beam air pump quite monopolized the

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field, therefore the author gives a comparison of the two types. Considering first the comparative steam consumptions based on equal air and condensate handling capacity the author claims that the steam consumption of the air ejector, plus that of a turbine-driven condensate pump, is lower than that of the twin-beam air pump, even if the latter is arranged with a dry and a wet cylinder. The weight and space requirements are also decisively in favor of the air ejector outfit.

Other comparative advantages of the air ejector enumerated by the author are:

It has no moving parts nor valves, does not require lubrication, nor attendance during operation.

Its operation is noiseless, simple and reliable.

No foundations are required and no restriction as to location exists. It is to all intents and purposes a piece of pipe.

Since there are no moving parts there is no wear, and consequently the maintenance costs are practically nil.

When using a steam-air ejector the feed water carries less absorbed air into the boilers than when using a twin-beam pump. The condensate pump forms a self-contained unit. All the attention it requires is to see that its ring oiling bearings are kept filled with oil. The discharge head of the condensate pump is not limited, as is the case with the twin-beam air pump. Since it operates independently from the air ejector the pump has greater flexibility and can easily take care of large amounts of condensate without influencing the air-handling capacity. This is not possible, it is claimed, with the twin-beam air pump, in which the air-handling capacity is limited by the piston speed and simultaneously by the amount of condensate removed.

When using air ejectors and condensate pumps a considerable saving in weight and cost of piping can be made because the pipe sizes are smaller, as much higher velocities are permissable when dealing with water and air separately.

Steam-air condensers are generally supplied in pairs for marine condenser installations, this subdivision having the advantage of reducing the steam consumption by operating with one under light loads or when the installation is air tight, also of providing additional capacity in case of unexpected leakage. In larger installations sometimes three or even four air ejectors working in parallel are being used with two condensate pumps.

This subdivision also gives an absolute assurance against a total shut-down, which might occur when using a single reciprocating type air pump.

In concluding the author points out that the steam-air ejector was first tried out on board a ship about four years ago. It was feared that, by discharging the commingled steam and air into the feed tank, the amount of air absorbed by the feed water would be greater than that when using a reciprocating piston air pump. Comparative tests have shown that this fear was groundless.

The amount of air absorbed in the feed water, when using the ejector, was 35 percent less than that when using the twin-beam air pump.

With this obstacle removed, the air ejector rapidly gained the confidence of shipbuilders and marine engineers, so that there are today, according to the author's knowledge, over five hundred ships built in this country equipped with steam-air ejectors. About one-third of these have been in successful operation for periods up to two years.

From this it would appear that the steam-air ejector today occupies a position among the air pumps similar to that occupied by the steam turbine among steam-operated prime movers. Its advantages, reliability and simplicity, are dominating factors which, in the author's opinion, will gradually make its adoption as universal as that of the steam turbine.

DISCUSSION

M. L. Katzenstein: In many ways the paper is interesting and I agree fully with many features in the discussion of the operation of the ejector itself. In other respects the paper is misleading and in some instances quite incorrect.

The development of the marine condensing unit has not kept pace with stationary practice. With full appreciation of the modifying conditions, I see no reason why, as stated on page 1, the limit for marine condenser performance should be placed at 1½ inches for 60 degrees, or 2 inches for 70 degrees, whereas a stationary plant is designed for and readily maintains 1¾ inches and in some cases 1½ inches with 70 degrees, the latter corresponding to a saving of 2½ to 3 percent in the steam consumption of the main turbine.

On page 2 reference is made to air leakage and Plate 1 gives curves stated to show *"permissable* air leakage for marine surface condensers," which would be very interesting if correct and authoritative. Recent estimates on the smaller sizes show allowances which run from 50 to 100 percent greater than shown on Plate 1.

The separate wet and dry system referred to by the author has been used by the Worthington Company for many years in stationary practice and has been extended to include vertical marine pumps of the twin type. The steam ejector has the important advantage for marine work of reduced space and weight, but many disadvantages and complications. The battleships, cruisers and destroyers of the United States Navy were equipped with the twinplex type of pump (upwards of 400 during this period for destroyers alone) and in a few cases where the ejector was installed by the Navy, it was only as an auxiliary or in conjunction with a pump of the twinplex type.

The statement is made that a steam ejector with a turbine-driven condensate pump will require less steam than a twin-beam air pump or even the twinplex pump with the wet and dry cylinder. This is absolutely incorrect and from actual tests we find that the twinplex pump will take only about 40 to 45 percent of the steam required by the ejector and condensate pump, operating at the same capacities. The efficiency of the twinplex pump is much greater than that of the twin pump and it covers the requirements of the separate wet and dry vacuum system.

There is another most important feature in connection with Plate 2. When the non-condensible vapors leave the condenser to enter the steam ejector, they are seldom cooled more than 10—perhaps 15—degrees below the temperature corresponding to the vacuum, but where an hydraulic vacuum pump is used, the vapors are reduced to the temperature of the circulating water. Where a steam ejector carrying 2 inches absolute in service receives the vapors cooled to say, 90 degrees, the hydraulic vacuum pump or rotative dry vacuum pump would handle vapors cooled to or saturated to 70 degrees, which would occupy approximately only 46 percent of the volume of the vapors going to the steam ejector, so that the steam ejector does 2.16 times as much work as it would if its vapors were cooled to the same temperature.

As to the mechanical efficiency of the ejector, at a recent convention, figures were submitted showing that the amount of useful work performed by the steam ejector represented in B. T. U.'s only .003 of 1 percent of the total evaporative heat of the steam delivered to the main

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turbine. This also gives some index of the efficiency of the steam ejector.

The author states that the steam required by the non-condensing ejector will be reduced 30 to 40 percent by the condensing ejector. The Worthington ejector tests show a reduction of approximately 50 percent. It will be found that the percentage of steam saved by using the condensing type of ejector is a very large factor and not to be argued down without a careful study of the heat balance.

The statement is made that the amount of air absorbed by the feed water, when the ejector is used, is 35 percent of that when the twin-beam air pump is used. The twin-beam air pump has been practically superseded in the latest installations by the twinplex or wet and dry pump. It is not believed that actual tests will show any increase over the ejector in the air absorption by the feed. This, however, would be to some extent modified by the design of heater and whether the exhaust is passed into the body of the feed or through a falling spray.

With regard to the weights, figuring upon the same quantity of air in both cases, the twinplex runs from 2 to 2½ times greater weight than the non-condensing ejectors with turbine driven condensate pumps, not approximately 7 to 1 as stated in the paper. In the case of many cargo vessels, the items of space and weight are not of prime importance.

It must be remembered also that the steam ejector, on account of lack of elasticity, must be installed in multiple units and I would like especially to impress upon the members the fact that the vacuum pump handles air and not steam and the old basis of attempting to rate pumps upon the quantity of steam handled must, before long, give way to an intelligent selection of size based upon the quantity of air used.

A statement should have been made in this paper, declared E. H. B. Anderson, of the valuable work in connection with the steam air ejector or augmentor which was done by Sir Charles Parsons in 1903 and 1904. The type which he developed at that time has been used in connection with all Parsons' turbines in the United States Navy.

In a recent turbine installation, the designers did not make sufficient allowance for the water drainage but when it came to the operation the condenser pipe was blanked off and an ejector used instead to take care of the drainage. While maneuvering at slow speed, this means was quite adequate to eliminate water from the turbine, but when driving ahead at cruising speed the ejector did not take care of the drainage. Three bad breaks in the turbines resulted. This matter of drainage is a very essential item in the proper operation of turbine drive. A separate condensate pump, or a separate ejector should be fitted low down in the drainage line. The steam consumption required of the pump or the ejector should be taken care of in computing the operating efficiency of the system.

The mechanical efficiency of the ejector is very low, being a fraction of a percent, but the thermal efficiency is extremely high, for only a very small amount of heat is lost in its operation, the greater amount of heat being returned to the feed water.

Launching of Ships in Restricted Waters

BY CAPTAIN H. M. GLEASON, CONSTRUCTION CORPS, U. S. N., AND LIEUTENANT COMMANDER H. E. SAUNDERS, CONSTRUCTION CORPS, U. S. N.

(This paper will be published in an early issue.)

Professor William Hovgaard related instances as far back as 1895 in which ships being launched under his supervision in Denmark were allowed but a thousand feet in which to be brought under control. At this time there were no previous data on launching ships in restricted waters and, necessarily, a rough estimate was made. The ships in question were launched successfully and the data compiled at that time served for the future information of those responsible for launchings at this one place.

When the scout cruiser *Chester* was launched in Fore river, rope stops were used as well as two friction brakes to check her down the ways. The friction brakes were nothing but wooden wedges sliding between planks. Unfortunately, the upper part of the brakes splintered and the effect was lost.

The application of stern masks in launching a ship is always a good practice, for it probably has more effect than any other method so far used to check a vessel. The application of the data compiled in this paper from model experiments is to be commended, for it is the first information that has been applied scientifically to this very important question.

FRIDAY AFTERNOON SESSION

The Propelling Machinery of the U. S. S. Leviathan

BY ERNEST H. B. ANDERSON

(This paper will be published in an early issue.)

DISCUSSION

A record of some of the personal experiences on the *Leviathan* when she was being put into condition for transport service were given by W. H. McKay. No information up to the reading of this paper has been released on the difficulties encountered in getting the ship ready for use. When she was turned over to the Shipping Board, there were no fires on board and no lights. All drawings and plans of the ship and her machinery, piping and the like, had either been destroyed or were almost illegible, so there was practically nothing aboard to use as a basis in tracing out the various systems.

American and British engineers went ahead with the work, however, and, in three months and 12 days, had steam up. The problem of rebuilding the turbines, supposedly wrecked by the German engineers, was solved by the Westinghouse and General Electric companies, as well as the Coe Brass Works, of New Britain, Conn. Men from the Westinghouse and General Electric Works went immediately to New York to install blades that were turned out by the Coe company, which shut down commercial production for two weeks in order to supply the blades in time. All necessary tools were made by the Brooklyn Navy Yard under Captain Jessup's supervision. The German chief engineer made the statement before leaving the vessel that the Allies would never be able to run her. In the one and one-half trips which she had made about four stages in one of the low pressure astern turbines had been wrecked. The tips of the blades on the first four rows of the last stage came very close to the casing and it is probable that under the very slight expansion, when steam was admitted, they rubbed against the casing. The heat generated in this way caused a distortion in the blades which aggravated the trouble and finally put the wheel out of commission. The trouble occurred where the blades were longest and most easily distorted.

In trying to find the trouble, the Germans had drilled 16-inch path through part of the blading at various points, but had never found out where the trouble really

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was. The trouble started in the first row and extended to the fourth, but, after this stage, none of the blades had been wrecked.

The *Leviathan* could not have used her backing turbines but she was probably good for 80,000 or 90,000 horsepower when going ahead. If it had been necessary to put in new casings for the turbines, the repairs would have taken six months. Fortunately, with the new blading installed, no trouble was experienced after the ship was put in commission.

The damage was not due to faulty installation, as has been suggested, but rather to faulty personnel.

There is no question but that the speed shown by the repair crews on various Germam ships being converted into transports was responsible in a great measure for the happy termination of the war.

Standard Lubricating Oil Systems For Geared Turbines

BY EMILE SCHMELTZER AND B. C. FERNALD

(This paper will be published in an early issue.)

DISCUSSION

C. R. Waller stated that until four years ago very little was known about the new vessels in America and Europe equipped with geared turbines. In 1906 a geared turbine ship in Vancouver was fitted with an oiling system of pipes having elbows and 45-degree angles arranged in a complicated network. The pump to take care of this system would have had to overcome a resistance equivalent to a 24-foot lift. Naturally a pump of this capacity was not installed and troubles with the oiling system were of constant occurrence.

Another instance occurred in which the engineers wished to install a gravity tank but the expense involved was not thought necessary. On the trial trip of this ship it was necessary to shut down the power six times in order to pump oil. The pressure operating valve would not work and the trouble could not be found. In the case of the gravity tank, it is always possible to tell on inspection whether the supply is getting low or not and whether there is trouble in the system.

One great necessity in any system is to keep the oil free of salt water. It is possible to lubricate machinery with oil and water but it is almost impossible to feed oil and water through any system. In the case of gears, salt water is very harmful, for even in a day or two they become covered with rust.

It has been the habit when turbines or gears in merchant ships have given trouble to blame the manufacturers but this paper will serve to educate turbine users that a correct oil system is necessary to proper operation.

Electric Propulsion of Merchant Ships

BY W. L. R. EMMET

(This paper is printed on page 814.)

DISCUSSION

E. A. Stevens, Jr., declared that the statement, that "in the case of warships the electric drive activities have been uninterrupted," is only true of warships built in this country and of a certain class.

Regarding the arrangement shown on Plate 1, it is very questionable whether there is very much space saved. The amount of room taken by the motor in the stern would be very close to that saved in the engine room; besides, there is no provision shown for ventilation of the motor room. I have been informed by the chief engineer of the Federal Shipbuilding Company that upon investigation it was found that this means of propulsion required more room and was heavier and more expensive than either the geared turbine or the reciprocating engine for the class of ships built by this firm. The generator being placed above the boilers, as shown, would be very impractical for four reasons. First, the space above the boilers would be very cramped. Second, the engine room would be considerably hotter. Third, the auxiliaries would be on a different level from the operating platform, which is very undesirable. Fourth, the difficulty of providing proper foundations for the turbine and gears. Very few engineers if any would care to go to sea in charge of an electrically propelled vessel, without means of communication between the motor and engine room.

On the second page, last paragraph, it is stated that the motor would be self-lubricating and only occasional inspection would be necessary. I would consider it very risky to leave this compartment with only occasional inspection, for if any trouble occurred it would very likely be between inspections and might result in a general disability before it was discovered.

I do not believe that any greater economy can be obtained with the electric propulsion than with the geared turbine. If it is advisable to use electric-driven auxiliaries, which I doubt very much, there is no reason why this type should not be used with the geared turbine outfit and the same economy be obtained.

Regarding reliability, I can see no advantage in the arrangement suggested in this paper for operating vessels with the main generating unit out of service, by having a motor generator set or rotary converter arranged so that the power of the auxiliary generators could be delivered to the main motor. This would be quite expensive for a piece of machinery that would be lying idle most of the time; besides, the auxiliary generators would have to be considerably larger than what would be necessary for operating the auxiliaries. As far as reliability is concerned, the reciprocating engine is as good as any. With the geared turbine of the cross compound type, reliability is assured without carrying any spare machinery.

It is stated that the efficiency of the generator is 95.6 and the motor 95.9, making a transmission efficiency of 91.6, including cable losses. If this be true, the cable losses must be zero.

Regarding the operating force, it is stated, "Conductor circuits are much simpler mechanically than pipes and mechanical motions, etc." This might be considered so by some people, but others think differently. Steam leaks are much easier to locate and repair than short circuits or electric leaks, and steam-driven auxiliaries are easier to repair than those driven by electricity; furthermore, the former is less likely to be damaged by water than the latter.

Parker M. Robinson pointed out that the generator efficiencies given in the paper, of 95 percent and 94.7 percent, are correct but the actual circumstances under which the efficiencies were determined are not given. In one case, with an oil of a medium viscosity, an efficiency of 94.2 percent was obtained, but with the same combination and a low viscosity oil, efficiencies as high as 97.5 percent have been obtained.

John C. Reid, in referring to a previous statement, that it might be possible to obtain good results with Diesel oil, engine-driven generators, said an attempt had been made a number of years ago on the Great Lakes to connect a 750-horsepower Diesel plant to generators on a 250-foot vessel. The electrical apparatus worked perfectly but, because the Diesel engine had no overload factor, the system developed an effective horsepower of only 600. The generator and the Diesel acted in opposition to each other and the Diesel never came up to power.

There would seem to be very little choice between the electric drive and the geared turbine drive, either from cost of installation, upkeep or efficiency.

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National Merchant Marine Association's Shipping Policy

THE council of the National Merchant Marine Association at a meeting recently held in Washington unanimously adopted resolutions calling on Congress to enact legislation for the prompt sale of Government-owned vessels. The association recommends that vessels of under 6,000 tons deadweight be sold with privilege of transfer of flag, and that the larger ships be sold to American individuals and firms only. It is also recommended that the entire fleet be sold within a period of two years.

It was the unanimous opinion of the council that the Shipping Board should be directed to dispose of the entire Government fleet, including the vessels obtained from Germany and those in the process of construction, and that purchasers of the larger vessels, whose sale is restricted to Americans, should be required to pay 25 percent cash, the balance of the purchase price to be met by deferred payments over a period of ten or fifteen years, these deferred payments to bear five percent interest, secured by first mortgages.

The resolutions provide further that, after a sale of a portion of the larger vessels, the unsold remainder shall be allocated by the Shipping Board, as far as practicable, to those who have purchased, on the basis of payment of a commission to the operating firms or corporations and payment by the operators of the proportion of the consolidated net earnings of the ships owned by the operators and the Government-owned tonnage which the operated tonnage bears to the total tonnage operated by such firms or corporations.

The association also recommends that those who purchase and operate ships in the foreign trade under this plan shall be exempt, in respect to the earnings of the ships, from all Federal excess profit taxes for a period of from ten to fifteen years, provided they be permitted to charge off ten percent of the net earnings of the ships on account of depreciation and deduct such amount in their tax returns as operating expenses. The amount of the earnings equivalent to the excess profit tax that would be payable is to be invested in new tonnage from American shipyards.

Finally Congress is called upon to enact special legislation to assist existing passenger lines in the construction and operation of new passenger tonnage of the highest class and latest design and type and to inaugurate and develop additional passenger and freight lines on routes which it is desirable, in the national interest, that direct passenger and freight service should be established.

The association will take immediate steps to bring its programme to the attention of Congress and the country. The House committee on merchant marine and fisheries has completed its hearings and reported favorably on the Greene bill, the provisions of which are outlined elsewhere in this issue, but the association will appoint a special committee to appear before the Senate committee on commerce in support of Senator Ramsdell's bill.

American Insurance and Classification

"TO MAKE our merchant marine a success, we must have our own American insurance and classification" was the keynote of the speech delivered by Homer L. Ferguson at the annual banquet of the American Society of Naval Architects and Marine Engineers, held at the Waldorf-Astoria on the night of November 15. Mr. Ferguson's entire speech was given the rapt attention of the thousand and more members and guests, representing to a larger extent than ever before the various elements entering into the building and operating of the American merchant marine.

The speaker, on account of his long experience as head of one of our leading shipyards and his present position as the president of the United States Chamber of Commerce, can speak authoritatively on all matters pertaining to our merchant marine and foreign trade generally, hence his sentiments above quoted should be given the most serious attention of all patriotic American citizens.

There is among us, unfortunately, a large class of men in important positions in the merchant marine, who, from lack of proper consideration, ultra-conservativeness or alien leanings, are not taking this warning to heart. Many new ships are being contracted for by private parties, and, unfortunate to relate, are being classed with alien societies, notwithstanding the fact that we now have a live, energetic and efficient classification society of our own. This society, representing as it does the best American talent in shipbuilding and underwriting, has thrived during the late war and has "classed" over 70 percent of the enormous tonnage turned out in American yards. To keep up its position and to enable it to retain its progressive efficiency it must have the unqualified confidence and patronage of all loyal Americans. The United States government has in every manner possible given its support without stint, and has signified its intention in every legitimate manner of continuing to back up this most important function of a merchant marine. Citizens should do as well in this respect as their governmental representatives.

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A Merchant Marine Referendum

THE Chamber of Commerce of the United States has submitted to the 1,236 organizations which form its membership a report of its committee on ocean transportation embodying recommendations for the disposition of the two thousand or more merchant vessels which the Shipping Board now possesses, or has under contract. As the vote of these organizations will determine the attitude of the National Chamber of Commerce on one of the most important questions that will come before this session of Congress, these recommendations deserve careful consideration. They are as follows:

1. That wooden vessels, and steel vessels under 6,000 tons deadweight, be sold on the best terms obtainable from American or foreign bidders.
2. That other government-owned vessels be sold to regional associations for transfer at cost to private individuals and corporations of the several regions.
3. That the government absorb the difference between the war cost and the present value, as a war loss.
4. That there be freedom from regulation as to routes and rates.
5. That there be restriction for a period of years upon transfer to a foreign flag of steel vessels over 6,000 tons deadweight purchased from the government.
6. That preference be shown for American underwriters, and that the underwriting market of the world be used for insurance not covered by American underwriters, without intervention by government insurance.
7. That encouragement be given to an American classification society.
8. That Congress be asked to make a general declaration of a policy to give aid toward the maintenance of a privately owned and operated American merchant marine.
9. That the operation of the competent American shipbuilding yards, on private account both as to yards and the vessels they construct, be continued.

With one exception these recommendations are in accord with the best judgment of the majority of shipping men as expressed in recent months. They are based upon sound patriotic principles and should receive the endorsement of the commercial interests throughout the country. If carried out, they mean an end of government ownership, and the establishment of a definite policy of government aid towards the maintenance of a privately owned and operated American merchant marine, insured and classed by American interests.

The one exception is the second recommendation which limits the sale of government-owned vessels of over 6,000 tons to proposed regional associations for transfer at cost to private individuals or corporations in their respective districts. While the formation of such associations would undoubtedly serve a good purpose in stimulating public and local interest in the upbuilding of an American merchant marine, nevertheless to delay the sale of ships until such regional associations are formed and purchasers found in these regions would probably mean a long continuation of government control and operation, which in itself would defeat one of the principal aims of these recommendations.

The sooner the American merchant marine is in private hands, the better. The sale of vessels above 6,000 tons should be effected as quickly as possible to any American individuals, firms or corporations, wherever located, that can meet the terms offered. Vessels do not operate solely from home ports, but go wherever business offers. The distribution of tonnage will adjust itself as the ports have business and terminal facilities to offer.

Wages for Crews on American and British Vessels

AS a comparison of monthly expenses for wages of officers and crews on American and British vessels, Emil P. Albrecht, president of the Philadelphia Bourse, gives figures for a class C American ship of 7,000 tons deadweight and a British ship of 7,500 tons deadweight. For the British vessel a bonus of £3 is included in addition to the regular wages, £1 being figured as $5. The figures are summed up in the following table:

	American Ship Coal-fired Scotch Boilers		American Ship Oil-fired Watertube Boilers		British Ship Coal-fired Scotch Boilers	
	No. of Men	Monthly Wages	No. of Men	Monthly Wages	No. of Men	Monthly Wages
Deck.....	18	$2,097.50	16	$1,947.50	16	$1,535.00
Engine Room....	24	2,677.50	16	2,027.50	20	1,760.00
Stewards.....	8	690.00	6	555.00	6	382.50
TOTAL.....	50	$5,465.00	38	$4,530.00	42	$3,677.50

From these figures it is seen that in the case of an American ship fitted with oil-burning watertube boilers there is a decrease of 12 men, or 25 percent, over a similar ship fitted with coal-burning Scotch boilers, and a decrease of $935, or 17 percent, in monthly wages. On the other hand a British coal-burning vessel as compared with an American coal-fired vessel takes 8 less men, or a reduction of 16 percent, and shows a decrease of $1,787.50, or 33 percent, in monthly wages. A British coal burner as compared with an American oil burner takes 4 more men in the engine room, or an increase of 10 percent, but shows a decrease in monthly wages of $852.50, or 19 percent. In other words it costs 48 percent more, as far as the wages of the crew are concerned, to operate an American coal burner than a British coal burner, and 23 percent more to operate an American oil burner than a British coal burner.

On British vessels four licensed engineers are not obligatory. If two licensed engineers are on board, the other two may be machinists. Comparing the American and British coal-burning vessels, it is seen that in the deck department the British vessel requires two less men and 20 percent less wages, in the engine department the British vessel requires four less men and 26 percent less wages and in the steward's department the British vessel has the advantage of two less men and 44 percent less wages.

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LETTERS TO THE EDITOR

Crude Oil Motors in Marine Practice

Editor Marine Engineering:

The writer notes in the October issue the article, "Crude Oil Motors versus Steam Engines in Marine Practice." In the summing up of the article the author speaks of crude oil motors of various types, and it is noted that in all of the engines mentioned there is no reference whatever made to an American engine of this type. All of the two cycle engines mentioned in this article are copies of the Mietz oil engines, and if references are to be made in such articles, the writer believes it would be only fair that some mention should be made of motors of standing, and particularly an engine that is the pioneer of its type. In fact there are several makes of engines mentioned in this article which the writer believes have a very limited reputation, and he further doubts very much whether half of these machines are even known to the engineers familiar with this class of machinery.

New York. J. T. O'CONNELL,
August Mietz Corporation.

Lake System of Dry Docks

Editor Marine Engineering:

I am interested to note the article by John Lake in the letters from marine engineers in your October issue. The system of dry docks mentioned may be new, but from a practical standpoint it would be too expensive to install and operate.

If the dry docks are located at sea level, it is self evident that any movement of water from one basin to the other must be done eventually at the expense of pumping. Otherwise, Mr. Lake will have developed a method of perpetual motion. If one lock is to be unwatered by releasing the water to lower level chambers, those chambers must at some time have been pumped out of an equivalent amount of water. The loss due to leakage means that more power would be required to do the same work. Also, the disadvantage would extend to the utilizing of a multiple of basins, causing interference and interdependence, which, added to the decreased efficiency, makes the scheme impractical.

Providence, R. I. F. W. ERICKSON,
Vice-President and General Manager, Marine Engineering & Dry Dock Co. of R. I.

Lubricating Systems for Geared Turbines

Editor Marine Engineering:

Your editorial in the September issue on the subject of "Lubricating Systems for Geared Turbines" is timely and very interesting.

The writer has had considerable to do recently with the furnishing of oil filtering equipment for the lubricating systems of vessels being constructed for the Emergency Fleet Corporation. On something like 300 to 400 turbine driven vessels, which are being fitted with Peterson marine type of oil filter, manufactured by the Richardson-Phenix Company, the lubricating systems are laid out practically along the lines mentioned in your editorial.

However, we wish to make strenuous objection to your statement that the filter used in an oiling system is a danger, in that it may become choked and interrupt service.

The Peterson marine type filter, which is strictly a low pressure or "gravity" filter, is so designed that in event of it being entirely neglected (a remote possibility) the oil will automatically overflow the filtering compartment and the circulation of oil will not in any way whatsoever be interrupted.

Large numbers of these systems using Peterson marine type filters have been in successful operation on vessels constructed by practically every prominent shipbuilder in this countrty, and therefore I believe that your statement in regard to filters being a possible source of danger in the line of a circulating system should be refuted.

New York. EDWIN M. MAY.

A Belated Tribute to Noah and His Nautilus

Editor Marine Engineering:

During the July rainy season when shut-in vacationists were censuring Jupiter Pluvius, St. Swithin and the Weather Man, and water courses of hitherto regular habits and staid respectability were disregarding traffic regulations and ruthlessly disarranging the adjacent scenery along their banks, the timely suggestion was made that the world's greatest shipyard at Hog Island should become a National Institution for the building of Noah's arks. The threatened distress from the flooding of houses could thus be avoided and the perplexing question, "What should be done with Hog Island?" would be satisfactorily solved.

The house boat type of abode has for centuries past relieved congestion in Asiatic and some European countries, where the surplus population continually exceeds the housing accommodations, and there is an apparent need in this country for an improved type of river tenement or community boat to house the unfortunate homeless. The maintenance of a floating population by adapting the ark idea to 20th century requirements recalls to mind the remarkable achievements of shipbuilder Noah, the original apostle of preparedness, the chosen preserver of the human race and the patron life saver of the animal kingdom.

According to archaeological records of the ancient Chaldeans and Egyptians, which are more or less fragmentary and largely traditional, the Great Deluge is supposed to have occurred 38,460 years ago, or 36,541 B. C. Whether this prehistoric date is the correct period of antiquity or inaccurate by several milleniums, the fact still remains that the construction in a primitive era of a seaworthy craft, capable of housing and rationing for a full calendar year a restless menagerie of birds, beasts and insects, was an engineering and zoological feat that was more than marvelous.

This first wooden ship was a three story affair, 450 feet long (or the length of a modern city block), 75 feet wide and 45 feet high with a central side door. The construction details are omitted in the *Exodus* version, so we can only conjecture as to whether the side door was high enough to serve all three decks or whether inclined planes, hatchways or ladders provided access between levels. The single upper window, which was one cubit or 18 inches deep, was no doubt a continuous series of openings to permit of light and ventilation. The use of carrier birds to determine when the flood had subsided seemed to indicate that the high window could not be used for observation purposes.

Considering the primitive methods and meager facilities in this antediluvian age it is not surprising that Noah was six hundred years old before he was able to finish and equip the ark. We have no idea how many years or decades the building operation required, but are inclined

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to suspect that the mural hieroglyphics must have included the original versions of such patience and perseverance mottoes as, "It is never too late to begin," "Haste makes waste," "Never start anything you can't finish," etc.

When the pioneer shipbuilder began his life work and was subjected to the abuse and ridicule of the knockers in "his own home town," he must have experienced greater mental and physical anguish than our own skeptical civilization with the added aid of the public press, movie pictures and expert criticism inflicts on the modern inventor (the so-called crank?) who has the courage of his convictions. Granting that Noah used rule-of-thumb methods in building the ark to withstand the external elements and internal occupants, the rounding up of the birds, beasts, and bugs, the selection and capturing of the choice specimens, the stocking and preserving of universal rations and the regular feeding of the pets and prisoners must have been a herculean task for the strenuous Noah family. Such problems as the fresh water supply, sanitation, group segregation and policing the ark must have required expert veterinary skill and constant labor to avoid menacing the general health of the inmates and prevent jungle habits disrupting the otherwise happy cruise of the good ship *Ark*.

As we review in retrospect how Noah carried out his divine instructions and successfully accomplished the seemingly impossible feat of saving the human race from extinction, we are prone to wonder why conserved humanity in some past era in the world's history failed to express its gratitude by erecting a more fitting memorial to Mr. Noah than the little toy arks which are eventually wrecked in juvenile nurseries. H. T. MOORE.

Launching Experiment

Editor Marine Engineering:

During several recent side launchings on the lakes the drop was so great and the angle of heel was so pronounced that it was decided to try a few experiments to ascertain the correct angle of heel and the number of rolls it took a "canal sized" vessel to come to rest upon being launched under ordinary conditions. The accompanying plates with a short description will serve to illustrate the method used.

Fig. 1.—The "Tell-Tale"

On the after end of the engine casing, above the bridge deck, was hung a "tell-tale" consisting of a brass pendulum (Fig. 1) that would swing with the roll of the boat. A brass arc was arranged in connection with the pendulum, being divided into degrees, and a man as stationed at each side of the instrument who marked the angle of heel as the ship rolled.

LAUNCHING EXPERIMENT NO. 1

Name———————. Place—A Great Lakes Yard.
Hull E. F. C.—1836. Time—August 13, 1919, 7 A. M.
Dimensions—Length, 261 feet over all; 251 feet between perpendiculars; beam, 43 feet 6 inches; depth, 28 feet 2 inches.
Launching Draft—Forward, 4 feet 9 inches; aft, 7 feet 11 inches; mean, 6 feet 4 inches; displacement, 1290 tons.
Coefficients at above Draft—Block, .663; prism, .69; midship, .963.
Depth of Water—16 feet 5 inches; width of slip, 102 feet; length of ways, 40 feet.
Pitch of Ways—1½ inches = 1 foot.
Distance dropped from end of Ways to Water—39 inches.
Time from first roll to rest—35 seconds.
Density of Water—Fresh.
Center of Gravity above Base—16.9 feet.
Metacenter above Base—26.6 feet.
Metacentric Height—9.7 feet.
Angle of Heel—25 degrees.

LAUNCHING EXPERIMENT NO. 2

Name———————. Place—A Great Lakes Yard.
Hull E. F. C.—1837. Time—August 30, 1919, 7 A. M.
Dimensions—Length, 261 feet over all; 251 feet between perpendiculars; beam, 43 feet 6 inches; depth, 28 feet 2 inches.
Launching Draft—Forward, 4 feet 6 inches; aft, 8 feet 2 inches; mean, 6 feet 4 inches; displacement, 1290 tons.
Coefficients at above Draft—Block, .663; prism, .69; midship, .963.
Depth of Water—16 feet 1 inch; width of slip, 102 feet; length of ways, 42 feet.
Pitch of Ways—1½ inches = 1 foot.
Distance dropped from end of Ways to Water—43 inches.
Time from first roll to rest—35 seconds.
Density of Water—Fresh.
Center of Gravity above Base—16.9 feet.
Metacenter above Base—26.6 feet.
Metacentric Height—9.7 feet.
Angle of Heel—20 degrees.

The experiments were tried on the same type of boat and in the same slip. The displacement of both boats was the same, the drop being greater in the case of the second boat. The angle of heel was less in the boat with the greater drop. At a later date we hope to try similar experiments on boats with different coefficients.

J. L. GOBLE, Chief Draftsman,
Toledo, O. Toledo Shipbuilding Company.

The Reciprocating Man

O, woesome oor' that saw the birth
O' turbine thochts in Pairson's heid,
I wish that I was aff the earth,
Or else the turbine mon was deid.

I'm a receeprocatin' mon,
I love to hear the bearing bump,
Or yet, the piston groan and grunt,
That's relegated tae a pump.

This Whirligeein' thing I hate,
Fur whatna gude is it tae dea?
Tae see the fearsome thing gyrate
Gars me puir stummick gang aglee.

I widna care if it had ocht
Tae need a tender fitter's haund,
But it rins' sae weel sin it wis bocht
I havna had to slack a glaund.

I hate the tribe o' whirligegs,
It's jist a pinch o' steam, then "Scat."
I'm a receeprocatin' mon,
I stan' or fa' wi' Jeemie Watt.

—"WEE JAMIE."

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Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Main Engine Feed Pump Defect

In a certain ship installation the main feed pumps were driven direct from the pump levers and the hot well overflow pipe was led down the front of the main condenser, so that it could be observed from the starting platform by the engineer on watch. While the ship was under way, it was sometimes noticed that the precious feed water trickled from the pipe and went to waste in the bilges. Several times this trickle became a serious

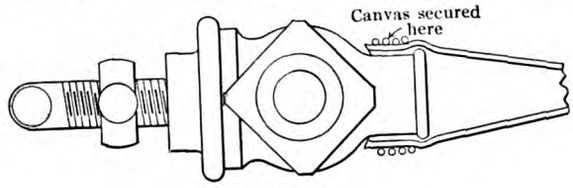

Fig. 1

overflow, necessitating the use of the auxiliary feed pump to assist in getting rid of the excess water in the hot well. In this case the pet valves had to be screwed down to the limit of safety, in the endeavor to obtain the highest pumping efficiency.

It was found that an excellent automatic petting device, Fig. 1, could be obtained by simply fixing a short length of canvas, about 3 inches long, to the pet cock. When wet, this worked like a charm and gave the minimum amount of air cushioning, at the same time preventing slogging of the water in the pump and the consequent shock to the pump and feed pipe range. The trouble was very intermittent—sometimes continuing for a watch but in several instances for days.

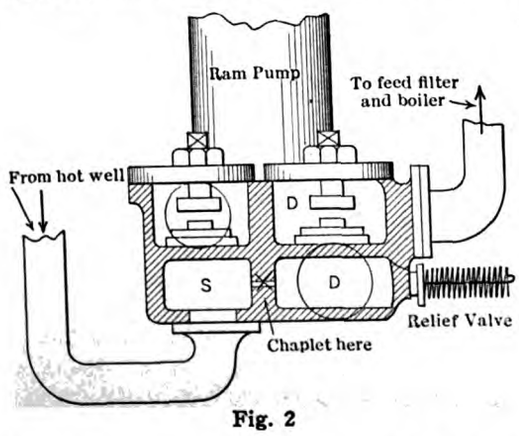

Fig. 2

Long runs at sea were the order for this packet, but when the opportunity came in port to investigate the trouble, the pumps and valves were put through an exhaustive examination and readjustment. The hot well, air vessel cover was raised ½ inch to allow better exit for the air and vapor from the feed water, but to no avail. For nearly a year no apparent cause for the leak could be found.

One day, however, while the suction and delivery valves on the feed pumps were being overhauled, a piece of slack metal was discovered projecting from the wall of the delivery chest. This eventually proved to be the head of a loose chaplet nail, Fig. 2, the body of which was quite slack in the wall of the delivery box. When the flat head of the nail was clear of the chest, the worn orifice had allowed an almost continuous leakage of feed water under boiler pressure to the suction side of the pump. The feed water thus accumulated in the hot well till it obstructed the free exit of the vapor delivered by the air pump. Naturally, water was lost by way of the overflow pipe until the pressure was reduced sufficiently for the head of the nail to close up the aperture again.

With a suitable chisel the defective nail was, with difficulty, cut away and after fitting a suitable bolt with grommets and washers, our trouble from this source ceased.

W. I. E.

Wear of Crank-Pin

In advance of "dressing up" the low pressure crank-pin of a triple expansion marine engine, a certain curiosity was aroused as to amount and location of wear. Since a simple use of outside calipers would not give the desired results the method shown in outline by Fig. 1 was devised.

A straight-edge is clamped on two T-shaped arms which are pivoted at the centers of the pin. Adjusting screws are provided so that, by gaging from the slight projection of pin beyond the web, to the underside of

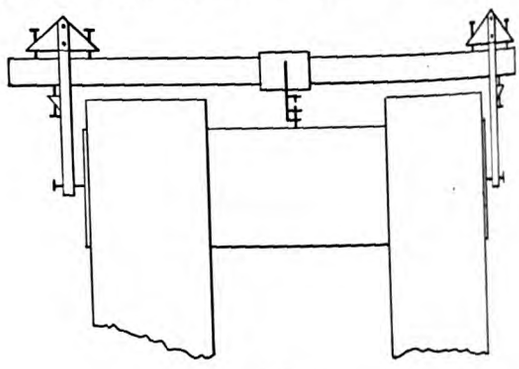

Fig. 1

bar, the straight-edge can be set parallel to the center-line of the pin. A sliding block on this bar carries a round pointed scriber, so arranged that it is free to move up and down a short distance. A light spring presses the point against the pin. Directly above the upper end of the scriber is a fixed screw with a ball point.

Now suppose the sliding block is set midway between the webs and the bar swung about its centers. The scriber point will follow the surface of the pin and any

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deviation from a true circle will cause an up or down movement.

The amount of this motion can be measured by the use of "feelers" between the upper end of the scriber and the fixed point. If measurements be taken at a number of places in the circumference, we obtain figures which

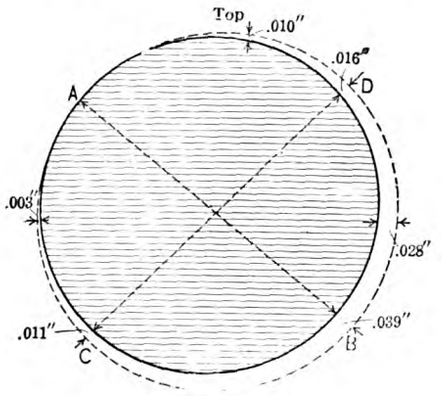

Fig. 2

may be used to plot a picture of the cross-section of the pin.

Fig. 2, showing the pin when the crank is on the top center, is the result obtained as a mean of several tests. The trueness of bar parallel to pin was checked in sev-

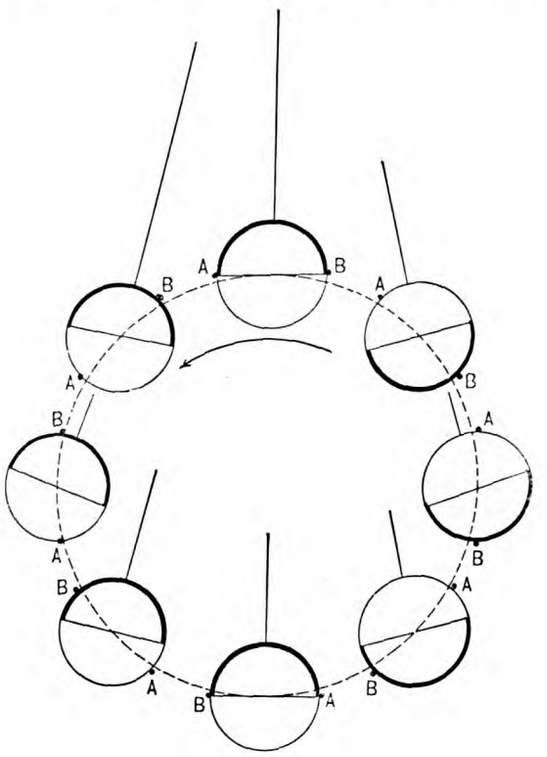

Fig. 3

eral positions and the figures are thought to be fairly accurate.

In any case, the interest is attached as much to the relative wear as to its precise amount. In our figure, which is not, of course, drawn to scale, we see the side *A* has worn the least, with a gradual increase in both directions toward *B*, where the wear is greatest.

A comparison of diameters shows *AB* is the smallest, being .039 inch less than the diameter of a circle through A, while *CD* is the greatest, being only .027 inch less than the circle diameter.

To "shape up" our pin to *AB* as a new true diameter will require filing heaviest at *C* and *D*—about .012 inch having to be removed. The same general result will be given by the use of a pair of calipers; but they would seem to indicate, by position of greatest diameter, that *C* and *D* were points of least wear. This is not the actual case, as our cross-section shows.

A point worthy of notice is that though the side *B* is worn badly and if the pin were to be trued up to the original center it would necessitate cutting a large amount of metal; at the same time, the pin is still fairly true relative to a center lying a little further over towards *A*. With the use of a semicircular face plate of a diameter *AB*, the pin could be faced up with only a reasonable amount of work, and to most any required degree of accuracy—dependent largely upon the patience of the operator.

In conclusion, Fig. 3 is submitted as showing clearly how the side *A* of our pin receives very little pressure at any time, while *B* receives the driving force on both up and down strokes. The pin is shown in different positions around the crank-circle; the heavily drawn semicircles indicating the half of pin which is, at the moment, receiving the pressure. A consideration of this diagram furnishes evidence as to the general correctness of Fig. 2.

The same apparatus of Fig. 1 was used also to measure the trueness of the surface of the pin in a fore and aft direction. It indicated, in this case, a number of ridges and grooves, ranging from a .006 inch to .010 inch variation from a straight line.

J. A. RUTAN.

New York.

Repairs to Fractured Bilge Pump Barrel

Our engines were triple expansion and indicated about 2,000 horsepower when driving at our deepest draft. The bilge pump on the installation was driven from the air pump levers and requires no description other than that the ram was made of a hollow brass casting fitted to a spear or rod attachment, which connected it to the air pump crosshead.

I had just about completed my inspection of all the running parts, preparatory to taking the watch over from the third engineer, when, passing back of the main condenser, I noticed that the ram was fairly hot. On casting a glance at the tank top under the pump, a momentary gleam of burnished metal caused me to investigate further. To my surprise, I found the bottom half of the pump barrel broken off and lying on the tank top. The gleam was caused by the polished surface of the ram, as it reciprocated past the fractured end of the barrel. After easing the gland, I walked over to the third engineer, who by this time was standing by the exit ladder of the engine room, and asked him how the bilge pumps had been working. When he saw what had happened, he recalled the fact that about half an hour previously he had heard a heavy thump, but had not been able to locate the cause.

As there were two bilge pumps on the engine, we stopped the main engines, after a consultation with the chief, and drew the plunger of the defective pump. The cause of fracture was found to be a ¾-inch iron hexagonal nut which had presumably been allowed to fall to the bottom of the barrel when at some previous overhauling the neck bushing was being drawn for renewal. This carelessness was attributed to some shore fitter, as it was highly improbable that any of the ship's staff would be

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guilty of such gross negligence. The nut showed signs on its faces of contact with the bottom of the ram. These marks were old, but evidently the accident had been brought about by the nut becoming tilted onto one of its faces, as this indication was confirmed by the appearance of the nut.

The following day we got the ship's carpenter to fashion a box, Fig. 1, and after coating the broken edges of the barrel with paint, the broken part was shored in place and liquid cement run into the box until it was filled. In

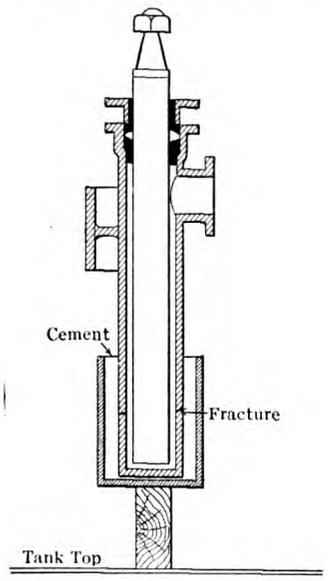

Fig. 1.—Temporary Repair at Sea

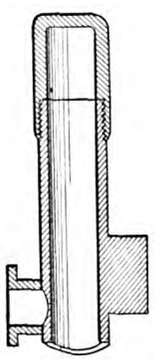

Fig. 2.—Showing Permanent Repair to Bilge Pump

a very short time the whole had set solid, and on stopping the main engines once more and refitting the ram, we were delighted to find that the repair was, as the chief said, "as good as gold."

We were bound from Newport News to Gravesend with cattle on our shelter deck and our holds full of grain. After discharging the cattle at Gravesend, we proceeded to Antwerp to discharge our cargo of grain. At the latter port mechanical repairs were effected, but I confess I was somewhat loth to see the cemented repair cut away, as it was as solid as a rock. In Antwerp (before the war, of course) the pump barrel was put in the lathe and a suitable extension made by simply threading the external surface of the barrel, as shown in Fig. 2.

W. I. E.

Disabled Piston of Quadruple Expansion Engine

The steamer on which the writer had the following experience was a twin-engined vessel, having quadruple expansion engines working at 225 pounds boiler pressure. The engines were balanced on the Yarrow-Schlick-Tweedy system and ran, as the saying is, "like a clock." We were bound from London to the Antipodes and were about a month on our way, with everything running well, when it became apparent to the watch engineers that some slight trouble was afoot in the first intermediate pressure cylinder of the port engine. A slight click was faintly audible. As the piston swept to and fro, the sound could only be discerned when one was standing by that cylinder on the top grating. The matter was noted for investigation, when we arrived at our destination, Melbourne, as it was not considered urgent enough for stopping the engine at sea.

On arriving at our destination, the piston and valve, as well as the metallic packing of the piston rod, were thoroughly overhauled, without giving any satisfactory result as to locating the origin of the sound. Curiously enough, after overhauling all this gear, while we were engaged on the coastal run, the sound was not apparent and of course the matter was dismissed from our minds as of no importance. Finally the day of departure for the return voyage came round and on my first watch homeward bound I was exasperated to note that the telltale sound was once more in evidence. Before my watch was over—we were just 12 hours on our 12,000-mile voyage—I was electrified by a resounding crash from the port first intermediate pressure cylinder. Just one crash and the engines seemed to run as before. I ran up to the port intermediate pressure cylinder and found the piston rod beginning to heat up. A second glance revealed the fact that it was running a little out of alinement. While I stood critically watching the swiftly moving rod, the piston commenced to grunt in the cylinder, so that I hardly had time to rush to the stop valve to stop the engines before they began to slow down of their own accord.

After stopping, the intermediate pressure cylinder cover was lifted, revealing three or four pieces of more or less crushed cast iron. A look underneath the cylinder cover showed that one of the core plugs had slackened back sufficiently to come in contact with the piston, when it had dropped out and jammed between the piston and cover. The piston rod was bent at the juncture with the piston, and the junk ring fractured in two places.

It was considered expedient to open up the piston valve also for examination, and very fortunate it was that this was done, as about a cubic inch of the fractured plug had been expelled through the upper steam port and was found lying on top of this valve.

In order that effective repairs could be made, which would take some days, it was decided to draw the piston rings, close up the cylinder and get under way again, allowing the steam to pass through the cylinder and do what little work was required to actuate the connecting rod, without being a drag on the engines. This worked out all right and so we carried on with some little diminution in speed. In about four or five days we were ready to replace the readjusted rings, which consisted of a muntz metal ring placed under the bull ring in order to bring the piston rings fair with the bore of the cylinder again and to set them up the exact amount that they were out of alinement. The piston rod was allowed to run, being fitted with metallic packing, which allowed a fair amount of side play to the rod and kept the gland moderately steam tight without undue heating.

The junk ring was considered safe though fractured and after all was assembled the engines ran very well almost normal again.

There are generally two sides to a question of any sort, and of course two sides to a cylinder cover, a fact sometimes overlooked by the rising generation of sea-going engineers when overhauling the engines. The covers are lifted and safely stowed aside to allow an inspection of the cylinders, pistons, etc., but I have never yet observed any of the juniors examining the underside for possible defects. If perusal of the above tends to inculcate more care in this particular matter, the writer will feel that his experience has not been without some good to his profession.

W. I. E.

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Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

This department is maintained for the service of practical marine engineers, draftsman and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

Approximate I. H. P. Formula for Reciprocating Engine

Q. (1026).—Is there any formula that will figure approximately the correct horsepower of a steam reciprocating engine, if the sizes of the high, intermediate, low pressure cylinders and stroke are known? If not, any other formula with the Revolutions Per Minute and other more complicated figures, data and parts of the machinery outfit known will be appreciated.

A. (1026).—There are several formulas which give the indicated horsepower approximately. The one below, which is from the "Guidance Specifications for Reciprocating Expansion Marine Engines," compiled by the North East Coast Institution of Engineers and Shipbuilders, is simple and will hold for ordinary triple expansion reciprocating engines installed in cargo steamers.

$$I.\ H.\ P. = \frac{D^2\ SN}{700}$$

D = Diameter of low pressure cylinder, in inches.
S = Stroke, in feet.
N = Revolutions per minute.

Seaton & Rounthwaite's "Pocket Book of Marine Engineering Rules and Tables" gives some additional formulas.

Power Formula for Motor Boat

Q. (1027).—How and why does the coefficient c in the speed formula $V = \frac{c\sqrt[3]{L \times B.\ H.\ P.}}{\text{Beam}}$ quoted in the September issue of MARINE ENGINEERING vary with change of form? N. M. S.

A. (1027).—A short, wide boat at ordinary speed will require more power than a boat which is long and narrow and the formula should take this into account. For a fuller discussion of this formula see article by H. H. W. Keith in *Motor Boating* for June, 1911, or "Propellers," by C. H. Peabody, page 28. In Keith's method, from which the following is taken:

$$V = \frac{C\sqrt[3]{L \times B.\ H.\ P.}}{B}$$ (Keith's Formula.)

L = Length over all, in feet.
B = Extreme beam, in feet.
$B.\ H.\ P.$ = Brake horsepower.

Type of Boat	Ratio L ÷ B	Values of C Miles	Values of C Knots
Cruiser	3 to 5	9 to 11	8 to 9.5
Runabout	5 to 7	8 to 10	7 to 8.5
High Speed		8 to 9	7 to 8

values of C can be obtained by using data from existing launches.

It should be noted that the formula is wrongly stated in the September issue of MARINE ENGINEERING.

Weight of Paint

Q. (1029).—Please publish an approximate formula for estimating the weight of painting to be allowed for in estimating the weights of a new design. C. A. S.

A. (1029).—The estimated weight of paint for design work is usually based upon the weight of bare steel hull. Cement is often included with the paint in making such an estimate. The writer has no definite figures at hand on this subject, but would figure that in the ordinary cargo steamer cement and paint would together equal about 2 percent of weight of the bare steel hull.

Angle of Roll

Q. (1030).—A ship 29 feet depth and 49 feet beam at a load draft of 20 feet, rolls 45 degrees; what would be the immersed section of deck, if any, at this relative angle of the ship to the sea level? What is commonly known to be the greatest angle a ship can roll and right itself? Is there any record of any ship's having rolled 90 degrees and righted itself? L. C. H.

A. (1030).—Your problem cannot be fully solved without more data, since a vessel's deck ordinarily has a sheer fore and aft, also tumble-home is common. It is necessary also to know the bilge radius as well as the deck camber.

If the above dimensions were applied to a flush decked, straight sided, square ended barge, the distance her deck would go under when tipped to an angle of 45 degrees can be easily calculated, and would be about 19.3 feet. In rolling waves are set up the effect of which on the angle of succeeding rolls is hard to predict.

The British navy, since the disaster of the *Capitan,* has recorded the rolling of its war vessels. The maximum roll recorded in Sir William White's "Naval Architecture" is 36 degrees from the vertical.

In the press lately there have been pictures of side launchings of some of the Lake type steamers. One, the *Lake Fugard,* according to reports, rolled 72 degrees from the vertical. The writer knows of no authentic case of a steam vessel rolling to this extent in a storm and still retaining steam. I do not doubt, however, that some light sailing vessels and yachts have rolled to this extent or even 90 degrees, and have not capsized, although records of this do not seem to have been published. The self-righting lifeboat, of course, and many keel yachts are unstable when bottom up.

Corrections to Answers in the September Issue

In answer (1018) to the question concerning "Engine and Propeller for Motor Boat," published in the September issue, Keith's formula should read:

$$V = \frac{\sqrt[3]{L \times B.\ H.\ P.}}{\text{Beam}}$$

The propeller should be 22 inches by 22 inches, instead of 22 inches diameter by 82 inches pitch, as stated.

In the sketch of relieving tackle in answer (1019) the line connecting the two tackles which passes from port to starboard quarter block was omitted. The line, of course, is continuous from the starboard quarter block through the starboard and port tackles and through block *A* till it is fastened to the small tackle or jig used to take up the slack.

The British Admiralty has revealed that during the entire course of the war Great Britain lost 2,479 merchant ships, aggregating 7,759,000 gross tons, through enemy action.

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Shipbuilding and General Marine News

Contracts for New Ships — Shipyard Improvements — Engineering Projects—Improved Appliances—Personal Items

AMERICAN SHIPYARDS PRODUCE 4,258,000 GROSS TONS IN PAST YEAR

Figures Show An Increase of 1,977,934 Tons Over Output in Preceding Year

During the twelve months ending November 1, 1919, American shipyards turned out 2,395 vessels of 4,258,000 gross tons, officially numbered by the Bureau of Navigation of the Department of Commerce. Though a small tonnage built for foreigners is included, nearly all the tonnage represents the expenditure of Treasury funds for shipbuilding.

The figures included in this statement show the shipbuilding activities in one year, or since the signing of the armistice. In the twelve months preceding the first of November, 1918, the corresponding output was 2,280,111 gross tons, part of which represents private investments in ships.

Lloyd's Register for 1918-1919 Shows Increase In Shipping

The annual report of Lloyd's Register of Shipping has been renewed, and the 1918-1919 report, together with a review of work done by the society during the war, is now in circulation. The annual reports were curtailed and finally discontinued because of the restrictions on shipping information during the war.

The report states that "at the end of June, 1919, there was being built under the inspection of Lloyd's Register of Shipping with a view to classification a larger amount of shipping than has ever been recorded in the history of the society, namely, 4,766,623 tons." Statistics show that in the last five years the society classed nearly 10,000,000 tons of new shipping.

In June, 1916, an American committee was established, and Lloyd surveyors reported on construction of vessels in the United States as follows: 1917, 107 vessels of 482,778 tons; 1918, 239 vessels of 945,912 tons; 1919, 470 vessels of 1,883,759 tons. "At a later date," the report states, "there were 419 vessels of 1,787,803 tons under construction in the United States with a view of classification with Lloyd's Register."

General Electric Absorbs American Marconi Company

The Radio Corporation of America has been formed with the backing of the General Electric Company to absorb the American Marconi Company, dependent upon the approval of the stockholders of the latter concern. The General Electric Company will contribute $2,500,000 to the Radio Corporation, part of which capital will be used in buying American Marconi shares held by the British Company.

Secretary Daniels Opposes Repeal of Charleston Dry Dock Appropriation

An attempt to repeal the appropriations for constructing a dry dock at the Navy Yard, Charleston, S. C., large enough to accommodate the biggest battleship of the Navy, as well as a channel of corresponding depth, was recently disapproved by Secretary Daniels, in a statement before the Senate naval affairs committee.

The discussion brought out the fact that the projected dry dock was absolutely essential to the proper development and maintenance of the Navy. The strategical importance of providing dry dock facilities for vessels in the south Atlantic was given great emphasis by naval experts. The Charleston navy yard offers the only suitable point south of Cape Hatteras for the construction of a dock that will accommodate large vessels. Three docks are being used at present on the Atlantic coast, at Portsmouth, N. H., Boston, Mass., and Philadelphia, Pa. The addition of the dock at Charleston would complete the programme for dock construction on the east coast.

Leviathan Allocated to the American Line

Announcement that the United States steamship *Leviathan* will be turned over to the International Mercantile Marine has been made by the Division of Operations of the United States Shipping Board. P. A. S. Franklin, president of the company, has long expressed a desire to obtain this vessel for use in service between this country and northern Europe.

The extensive changes which are necessary to convert the *Leviathan* from a troop transport to commercial uses and also to change her from a coal to oil-burning vessel, make it probable that she will not be ready to sail again for a number of months. It is estimated from the experience in reconditioning smaller vessels that about six months will be required for the work.

FUTURE SHIPPING POLICY PROPOSED BY SENATOR JONES

Legislation to Suspend Operations of the Emergency Fleet Corporation

Senator Jones, of Washington, has introduced two bills, one of which provides for the disposition or operation of merchant vessels of the United States, to stimulate interstate and foreign commerce, to encourage the development of the merchant marine of the United States (S. 3355), and one to create the United States Merchant Marine Corporation, and to sustain and build up the merchant marine of the United States (S. 3356).

In introducing these bills, Senator Jones stated that about 8,000,000 of the 12,000,000 tons of shipping in the foreign trade under the American flag should be Government-owned. In the discussion Senator Jones said: "We may differ about Government ownership but that cannot be made an issue at present. The Government owns nearly all the ships operating in foreign trade at present and we must not allow private parties to take the cream of this shipping and let the Government hold the balance to dispose of at a great sacrifice. It is granted that Government ownership should end as soon as possible but it must be brought about without unnecessary sacrifice. No one can reasonably hope that private enterprise and capital in the face of foreign competition and handicapped by our own experience, will be able to absorb and take over all this shipping in a short while."

Senator Jones also contended that unless private capital can take over the plant constructed by the Government at Camden, N. J., and now operated through the New York Shipbuilding Corporation, it should be retained and used for the construction of large ships for which there are no other facilities.

MERCHANT MARINE CORPORATION

In explanation of his bill to create a merchant marine corporation, under Government control; to operate the Government fleet for not more than thirty years, but without competing with private, established lines, Senator Jones said in conclusion:

"We now have the United States Shipping Board acting in a dual capacity. It was intended to be a great, regulatory, governmental agency, and is, in fact, doing the work of a great corporation. It cannot well serve both ends. What I propose is to divorce the Shipping Board entirely from building, selling or operat-

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ing ships and allow it to do the things it was created to do, and create a corporation, separate and independent of it, to operate, maintain and dispose of our ships in such a way as to give us an adequate merchant marine on a permanent basis."

The bill which Senator Jones said he would personally urge would abolish the Emergency Fleet Corporation, retain the present Shipping Board only in a supervisory capacity and create a new merchant marine corporation to operate government ships for thirty years, but not in competition with established private lines.

The alternative bill presented by the commerce committee chairman is a comprehensive measure "extending and superseding the present shipping board act and contemplating the inclusion of the duties and powers of the Shipping Board on all matters of operation, as at present."

Ultimate Private Ownership Favored

Ultimate private ownership of the Government's shipping property is favored by Senator Jones. The proposed merchant marine corporation, which would have no capital stock, would take over all the ships acquired by the Government during the war and all vessels and property in the hands of the Shipping Board and Emergency Fleet Corporation, for operation, sale, or other disposition with a view to maintaining a permanent American merchant marine. The new corporation would operate all government merchant tonnage and shipping property, while the Shipping Board would have a status similar to that which the Interstate Commerce Commission bears to the railroad carriers. The Shipping Board would have supervision over shipping rates and the Interstate Commerce Commission would be authorized, with the marine corporation, to require connections between rail and water carriers. Development of new shipping routes and lines for American shipping would be one of the principal functions of the Shipping Board.

The Jones bill declares for a Federal policy of having a merchant marine "sufficient to insure" American safety in emergencies and sufficient to carry the greater part of American commerce, together with ample shipbuilding and repair facilities, all ultimately to be owned by private parties and capital.

The proposed merchant marine corporation would be managed by nine directors, with headquarters at Philadelphia.

New Company to Build Raabe Oil Engines

The International Marine Construction Company has recently been incorporated under the laws of Delaware with a capitalization of $5,000,000. The officers and directors of the company are as follows: Robert Spiro, president; H. E A. Raabe, first vice-president; W. J. Bauer, second vice-president; H. E. Greene, secretary; W. A. Bischoff, treasurer; W. P. Morehouse and W. L. Harrison, directors.

The company, which has been formed for the production of Raabe oil engines, has established executive offices at 19-25 West 44th street, New York City. Special features of the Raabe heavy oil engine include the possibility of operation under an air pressure of fifty pounds per square inch with a start under full load without the use of auxiliary starting facilities. These engines are direct reversible, requiring neither clutch nor reversing propeller. The engines are also operated without air compressor or scavenging pumps. Variable speeds of any degree are permitted in both forward and reverse motion, thus providing the flexibility of the steam engine. These engines, the company claims, will operate on any grade of oil having sufficient hydro-carbon content to permit ignition.

New Machinery for S. S. Copan

Under the direction of Leonard B. Harris, naval architect, Woolworth building, New York, the *Copan* owned by the Cuyamel Fruit Company, New Orleans, La., is now being remodeled to double the ship's power. The present boilers, pumps, engines and auxiliaries will be removed, and two large boilers, 15 feet 6 inches in diameter and a triple expansion engine of 1,750 horsepower will be installed at the Harlan plant of the Bethlehem Shipbuilding Company, where the boilers and engines are being built.

Shipbuilding at the Chickasaw Yard

Four vessels known as design No. 2 are now being constructed at the yard of the Chickasaw Shipbuilding Company, Mobile, Ala. These vessels are similar to 30 vessels practically completed at the Kearny, N. J. yard of the Federal Shipbuilding Company, except that reciprocating engines are being used instead of turbines. Two of the vessels are fitted for oil burning and two for coal fuel, but all the vessels are arranged so that they may be easily converted to use either fuel. The vessels will develop a sea speed of 11 knots at 27-foot draft. The daily fuel consumption is estimated at 44 to 50 tons of coal and 32 to 35 tons of oil. Each ship is being equipped with ten 5-ton booms and one 30-ton boom to handle cargo from the four large holds by means of twelve steam winches.

The six vessels being constructed according to design No. 17 will be turbine driven. These vessels will develop a sea speed of twelve knots at 26-foot draft, with a daily fuel consumption of about 38 tons of oil. Two 5-ton booms, ten 8-ton booms and two 30-ton booms handle carge from five holds by means of 15 steam winches. These ten vessels are intended for service in the export trade of the United States Steel Products Company.

Contract Let for 9,600-Ton Vessel

The Bath Iron Works, Bath, Me., has received a contract for a 9,600-ton steamship from the Crowell & Thurlow Steamship Company, 131 State street, Boston, Mass.

Larger Naval Base at Mare Island Recommended

In a conference held between Secretary Daniels and a board of naval experts at Mare Island, Calif., recommendations were made to extend the facilities of the island so that it might be used as a greater naval base than at present.

It was suggested that there be provided at the south end of Mare Island, bordering on Carquinez straits, a berthing and docking station of two dry docks, berthing space with additional fleet storehouses; that the Pinole shoal channel be enlarged to a section of 500 feet in width and 40 feet depth at low water; that the present ammunition depot at Mare Island be removed to the north end of Mare Island, or to some other isolated location in San Francisco bay, accessible to tugs and ammunition barges; and that Congress be requested to approve the construction programme as laid down and create an apportionment of not less than $5,000,000 for the beginning of the work.

Plans for Thousand-foot Ship Cancelled

John Barton Payne, chairman of the United States Shipping Board, has announced the cancellation of all plans for the two 1,000-foot passenger ships, which were to have been built for the Shipping Board. Tentative plans for the vessels had been drawn and approved, so that construction could have been commenced almost immediately. The action suspending these vessels from the construction programme was taken in pursuance of the policy to eliminate all work not absolutely essential at this time.

Waterhouse Will Build $2,000,000 Pier at Seattle

The Frank Waterhouse Company, Seattle, Wash., has applied to the Seattle Port Commission for a permit to build a pier at the northwest section of the West Waterways. According to the plans submitted to the commission, the Waterhouse Company seeks to extend its property 155 feet on to the Railroad avenue waterway extension. If permission is granted for this construction, it is understood that the expenditure for the pier will be about $2,000,000.

Current Prices Quoted for Ships Held by the Shipping Board

Quotations submitted by the United States Shipping Board for vessels of 7,800 tons built at Hog Island are $215 per ton. Other quotations include vessels of the *Frederickstadt* type of from 3,000 to 4,200 tons, such as were built on the Great Lakes, at $200 per ton, and 5,350-ton carriers, built by the Submarine Boat Corporation, at $210 per ton. The ships of the 8,800-ton size are quoted at $220 per ton, while the 10,000-ton products of the Skinner & Eddy yard on the Pacific coast are listed for sale at $225 per ton. Wooden vessels are being held for $90 per deadweight ton.

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Electric Rivet Heating Device

An electric rivet heater has been placed on the market by the General Electric Company, Schenectady, N. Y.

The basis of the design is a transformer rated at 15 kilowatts mounted on angle iron legs, which may be fitted with wheels. At the front of the transformer, two copper bars are fitted with heavy, air cooled electrode blocks of cast copper, while under these is another copper block which acts as a support and as an electrical connection for two rivets in series. When the rivets are in place on the block, the electrodes are allowed to drop on the heads, thus completing the circuit and commencing the heating process. The two electrodes may be raised independently by two foot pedals, gravity being sufficient to lower the electrodes

Electric Rivet Heater

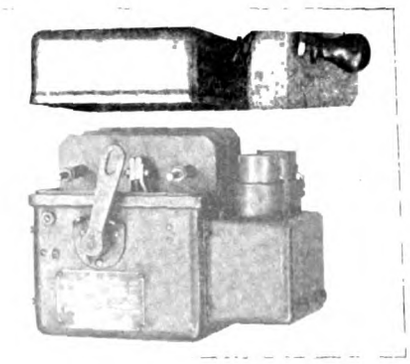
when the foot is removed. A primary tap switch mounted on the back legs of the machine gives all the variation needed for different lengths and diameters of rivets and rate of heating desired.

The sizes of heaters so far developed are a 5 kilowatt, two jaw for rivets up to ½ inch, and a 15 kilowatt, two jaw for rivets up to ⅞ inch.

Safety Starting Switch

Safety for the operator, safety for the motor and equipment and safety for itself are the three features embodied in a new type of starting switch for a small induction motor that is being put on the market by the Westinghouse Electric and Manufacturing Company. It is claimed that the switch is accident proof and well nigh fool proof.

The action of the switch is automatic and consists of strong springs attached to the contact parts and controlled by a



"Fool-Proof" Starting Switch

trigger. This trigger is released by overload, failure of power or by hand. When the switch passes the neutral point, the spring snaps it the rest of the way. The switch is shown in the accompanying illustration. Live parts are entirely enclosed in a dust-and-dirt-proof case.

When power leaves the equipment, a low voltage, protective relay releases the trigger and throws the switch. Upon the return of power, it is necessary for the operator to move the handle first to the reset position and then to the running position, before the motor can again be started.

Any undue overload causes the overload relay to release a trigger, which opens the switch as if the voltage failed. An overload throws out the switch and it must be reset before the motor can again be started.

Two sizes are made, each for use on two and three phase motors, with voltages up to 600. Type No. 815 starts motors of 10 horsepower or less, while Type No. 816 starts motors up to and including 25 horsepower.

PERSONALS

The following appointments have been made at the Newport News Dry Dock and Shipbuilding Company, Newport News, Va.: S. L. Wood, vice-president; C. E. Graham, treasurer; W. Gatewood, works manager; and H. F. Norton, naval architect.

J. Benton Porter, ship propulsion specialist, has been transferred from the Philadelphia office to the New York office of the General Electric Company, Equitable building, 120 Broadway, New York.

H. C. Higgins, formerly district manager, Emergency Fleet Corporation, at 301 South 10th street, Philadelphia, Pa., has become general manager of the Vulcan Iron Works, Jersey City, N. J.

Samuel B. Crosby has been appointed naval architect for the Newburgh Shipyards, to assume charge of the hull drafting room, the position left vacant by the departure of J. R. Preston for North Carolina.

Captain George L. Norton, editor of the *Marine Journal,* New York, has decided to retire from the active editorial management of the magazine, although he still will retain a financial interest in the publication. Winthrop L. Marvin, who has lately become secretary and manager of the American Steamship Association, and Winfield L. Thompson will act as editors.

The Mobile Shipbuilding Company, Mobile, Ala., has announced the resignation of Frank McLaughlin, formerly general manager. H. L. Brittain, president of the company, will be in direct charge of the plant until a successor to Mr. McLaughlin is named.

Robert McGregor, formerly general manager of the Federal Shipbuilding Corporation, Kearny, N. J., has been elected vice-president of the Green Star Steamship Company.

Captain Byron L. Reed has been placed in charge of the Coast Guard Service at the port of New York, succeeding Captain Godfrey L. Garden.

Major John Eldridge Cushing will succeed J. H. Rosseter as chief of the Division of Operations of the United States Shipping Board.

J. F. Andrews has succeeded L. A. Cholot as head of the European Trade Department of the United States Shipping Board.

John J. Flaherty has been appointed secretary of the Shipping Board and of the Emergency Fleet Corporation.

F. J. Tucker, assistant general manager of the Merchant Shipbuilding Corporation, Harriman, Pa., has been made general manager of the company's plant at Chester, Pa.

W. T. Wilson, works manager of the Harriman yard of the Merchant Shipbuilding Corporation, has been made assistant general manager. William Kennedy will succeed Mr. Wilson as works manager.

Professor Herbert C. Sadler, naval architect and consulting engineer of the United States Shipping Board, has resigned to resume his former work as professor of naval architecture and marine engineering at the University of Michigan. Mr. Sadler will also take up his general consulting practice again.

Arthur L. Busch, shipyard manager of the Bethlehem Shipbuilding Corporation, Ltd., Moore Plant, Elizabeth, N. J., has recently changed his name to Arthur L. du Busc. The new surname was the real family name of Mr. du Busc's French ancestors from the years 1315 to 1791. During the war, owing to the Germanism attached to the name of Busch, Mr. du Busc was inconvenienced. This experience prompted him to take legal action to change the spelling of his name.

Captain Felix Riesenberg, former commander of the New York Nautical School training ship, *Newport,* has succeeded Edward Frank Allen as editor of the National Marine, the monthly publication of the United States National Marine League.

A. R. Gilham, formerly with the St John Dry Dock and Shipbuilding Company, New Brunswick, has been appointed managing director of the Canadian Vickers, Ltd.

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Marine Construction News of the Month

Ship Contracts—New Ship Concerns and Shipyard Improvements—Terminal Projects—Government Contracts

SHIP CONTRACTS

The Atlantic Gulf & West Indies Steamship Lines, 11 Broadway, New York, it is reported, will spend $16,000,000 in tankers. Contracts for eight tankers have already been awarded to the following companies: the Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa.; the Sun Shipbuilding Company, Chester, Pa., and the Newport News Shipbuilding Company, Newport News, Va. These tankers were designed by Theodore E. Ferris, naval architect and marine engineer, 30 Church street, New York. Deliveries are to begin in 1921.

The Vacuum Oil Company, 61 Broadway, New York, has placed an order for one 10,000-ton oil tanker with the Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., and it is also stated that the Pan-American Petroleum and Oil Company will order five ships of this type.

The New York Shipbuilding Corporation, Camden, N. J., has received a contract from W. R. Grace & Company, 7 Hanover Square, New York, to build a 10,000 deadweight ton tank steamer. The price for this ship is in excess of $200 per deadweight ton.

The Moore Shipbuilding Company, Oakland, Cal., will commence work on three 10,000-ton tankers, a contract which the United States Shipping Board has reinstated.

The Submarine Boat Corporation, Newark, N. J., has been awarded a contract for the fabrication of four 5,350-ton ships. These vessels are to be assembled at Palermo, Italy.

The McDougal-Duluth Shipbuilding Company, Duluth, Minn., has received a contract for two freighters from Norwegian ship owners.

The Shawmut Steamship Company, 60 Federal street, Boston, Mass., has placed an order for two 10,000-ton shelter deck, cargo steamers of 13 knots speed, with the Merchant Shipbuilding Corporation, Bristol, Pa.

The Alabama Dry Dock & Shipbuilding Company, Mobile, Ala., has been awarded a contract by the Texas Oil Company, 17 Battery Place, New York, to repair the ship *Edward Sewall,* damaged in the hurricane that swept the Texas coast September 13. The cost of the repairs will be approximately $90,000.

The Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., is building six tankers for the Standard Oil Company, two at the Sparrows Point plant and four of 12,600 tons each at the Fore River plant.

The Federal Shipbuilding Company, Kearney, N. J., is building two vessels for the Freeport Texas Company, delivery of which has been promised early next year. One of these is a 50,000-barrel oil tanker and the other a 6,000-ton freighter.

The United States Shipping Board has opened negotiations with three of the large shipbuilding companies, for reinstatement of contracts for the construction of ten tank steamers suspended since the signing of the armistice. Negotiations are being conducted with the Bethlehem Shipbuilding Corporation, Ltd., for the construction of three tankers at the Alameda, Cal. yard, with the Baltimore Shipbuilding and Dry Dock Company for four at Baltimore, and with the Moore Shipbuilding Company at the Oakland, Cal. yard. The total tonnage involved is over 100,000.

Plate, Shapes and Bars for Tank Ships.—Two Pacific coast shipyards are inquiring for 20,000 to 40,000 tons of plate, shapes and bars for tank ships to be built there.

Ship for the Italian Government.—Italian shipbuilding companies have pledged themselves to supply 7,000,000 tons of new ships during the next two years and 1,000,000 tons the third year on condition that the Government promises not to change the maritime laws for at least fifteen years.

Two Battleships, Brooklyn, N. Y.—The keel for the battleship *South Dakota,* 42,000 tons, will be laid about January first at the Brooklyn Navy Yard and work on her sister ship, the *Indiana,* will be begun soon after. When completed these dreadnaughts will be the largest and most powerful of their type in the world. They will carry batteries of 16-inch guns, will be 666 feet long, use oil for fuel and be fitted with electric drive.

New Ships for French Line.—Contracts for the construction of 300,000 tons of new ships have been placed by the French Line with British and French shipyards, deliveries to begin next spring. In addition the French Minister of Marine has ordered ten cargo vessels and six liners to be built; the latter are for use in the Indo-China traffic.

Passenger Ships, Sparrows Point, Md.—The Emergency Fleet Corporation has altered its plans at the Sparrows Point yard of the Bethlehem Shipbuilding Corporation. Officials of that company have announced that the design for eight 10,000 deadweight ton transports has been changed so that they will be modern passenger ships. The passenger ships will be 535 feet long with a 72-foot beam and a 50-foot depth. Two hundred and fifty-three first class passengers and three hundred steerage passengers can be accommodated by the liners, which will have a large freight-carrying capacity. The work on these ships, which has been delayed for some time, owing to the change in design, will be speeded up.

Fleet of Merchant Vessels for the Argentine Government.—Dispatches from Spain announce that the Argentine Government is negotiating with the bank of Spain for a loan of $100,000,000 which will be used for the construction in Spanish shipyards of a large fleet of merchant vessels for Argentine.

Cancellations of the Emergency Fleet Corporation.—The Emergency Fleet Corporation has cancelled contracts with the American International Corporation for 23 troop and cargo ships which were to have been built at Hog Island and contracts with the Submarine Boat Corporation for 52 ships which were to have been built at Newark Bay. Aside from the action taken in the case of the vessels under construction at the yards of these companies, only 12 ships totaling 60,250 tons deadweight have been suspended from the active program of the Emergency Fleet Corporation. These suspensions include four ships at the Mobile Shipbuilding Company, Mobile, Ala., two at the Todd Dry Dock and Construction Corporation, Tacoma, Wash., three at the Manitowoc Shipbuilding Company, Manitowoc, Wis., two at the Toledo Shipbuilding Company, Toledo, O., and one at the Bayles Shipyard, Inc., Port Jefferson, N. Y. After these deductions, the program still calls for a merchant marine of 2,307 vessels aggregating 13,475,132 deadweight tons. The contemplated plan for building two 1,000-foot passenger vessels for the Emergency Fleet Corporation and for which tentative designs had already been drawn and approved, have been definitely cancelled. This cancellation ends any attempt that might be made in the immediate future for constructing large passenger vessels in American yards.

The Newburgh Shipyards, Newburgh, N. Y., since its organization has been building 9,000-ton cargo carriers for the Emergency Fleet Corporation. The contract with the Emergency Fleet Corporation called for twelve of these vessels. Three more are to be built before the contract is completed. The company has taken contracts for four vessels for private account. Two of these vessels will be equipped with geared turbines and oil burners. The keel of one of these, a 7,500-ton steamer for the Union Sulphur Company was laid on October 18. The other two steamers are for passenger service for the Cuyamel Steamship Company, New Orleans, La., and will have a deadweight capacity of 2,500 tons, and will be 330 feet long. These vessels have been designed by William Gardner.

The Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa., is repairing the steamship *Olean,* at its Wilmington, Del., plant. The *Olean* was sunk off the Spanish coast as a result of coming in contact with a German mine, which happened in December, 1918. The vessel remained under water for seven months, when the engineers raised the hull and towed it to Marseilles. The French Government repaired the vessel so that it could return to this country for reconditioning.

The William Cramp & Sons Company, Philadelphia, Pa., has been awarded a contract to make extensive repairs to the Lighthouse tender *Columbine* of the Baltimore district, at a cost of $50,000.

The Dubuque Iron Works, Dubuque, Iowa, is constructing two motor yachts, 65 feet long, 12 feet wide, for the Daily Service Corporation, Memphis, Tenn.

The Clooney Construction and Towing Company, West Lake, La., has received contracts for the construction of two small and two large barges and one dredge hull.

The Pittsburgh Steel Company, Pittsburgh, Pa., has received a contract from J. M. Hammit, to build a steel barge 350 feet by 45 feet by 11 feet.

The Tebo Yacht and Basin Company, Brooklyn, N. Y., has recently received a contract from the Donald Steamship Company, Inc., 17 Battery Place, New York, to build two steel vessels of 1,800 deadweight tons each, especially designed for use in the West Indian fruit trade. The vessels will make 13½ knots, and will be delivered in the spring of 1920.

Two 415-foot Fruit Vessels, New York.—William Gardner, naval architect, 1 Broadway, New York, has designed two 415-foot fruiters with a speed of 17 knots for fruit and passenger service for New Orleans parties.

The Japanese Government has decided on an eight-year naval programme costing $824,000,000, including the construction of four 40,000-ton battleships, four battle cruisers, twenty light cruisers, eight destroyers, seventy submarines and thirty other craft.

Hudson River Passenger Vessel.—The Hudson River Day Line, Desbrosses street, New York, has under consideration the building of a vessel on the lines of the steamer *Robert Fulton.*

Two Freight Steamers for Eastern Steamship Lines.—Theodore E. Ferris, naval architect and marine engineer, 30 Church street, New York, is preparing plans and specifications for two freight steamers to be built for the Eastern Steamship Lines. Mr. Ferris has

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also prepared plans and specifications for the conversion from coal burning to oil burning of the steamers *Camden, Belfast, Calvin Austin, Northland, Governor Cobb* and *Governor Dingley,* which are operated by the Eastern Steamship Lines on their regular runs. The work of converting these steamers, which will soon be contracted for, involves large expenditures.

The Southwestern Shipbuilding Company, San Pedro, Cal., according to a statement reported to have been issued by Marco H. Hellman, president, has secured a contract involving $20,000,000 from the Emergency Fleet Corporation to build ten vessels which will be operated between the Pacific coast ports and Boston. The office address of the company is 222 H. W. Hellman Building, Los Angeles, Cal.

The Standard Oil Company of California, San Francisco, Cal., has recently placed an order for three small coastal vessels with Pacific coast yards. The vessels range from 1,200 to 4,000 deadweight tons. These contracts are in addition to the recent order for a 2,800-ton motorship, placed with the Union Construction Company, Oakland, Cal.

The Standard Oil Company of Louisiana, New Orleans, La., is about to place a contract for six oil barges with an eastern shipyard.

The Staten Island Shipbuilding Company, with office at Richmond Terrace and yards at Port Richmond, Mariner's Harbor and Arlington, Staten Island, has received a contract for six barges of the car float type from the Standard Oil Company of New York, 26 Broadway, New York. These barges will have a capacity of 250,000 gallons of No. 6½ oil in five tanks. The vessels are 150 feet long, 27-foot beam and 11 feet 6 inches molded depth.

Stephens Brothers, Stockton, Cal., are building the following vessels: one freighter, 65 feet long by 24-foot beam, equipped with a three-cylinder 60-horsepower Union engine; one light tow-boat, 30 feet long by 7-foot beam also equipped with a Union motor; four commercial runabout launches equipped with Wisconsin motors.

The Todd Shipyards Corporation, 15 Whitehall street, New York, holds a contract for one self-propelled oil barge of 1,450 tons displacement for the Sinclair Consolidated Oil Corporation, 120 Broadway, New York. This vessel is to be delivered eight months after the contract was placed (July). The machinery will be installed by the White Fuel Oil & Engineering Company, 601 Washington street, New York.

The Union Construction Company, Oakland, Cal., has recently been awarded a contract by the Standard Oil Company of California, to build a 2,800-ton oil tanker equipped with Diesel engines. The contract for the engines is held by the Skandia Pacific Engine Company, Oakland, Cal.

The Vacuum Oil Company, 61 Broadway, New York, has placed an order for one oil tanker with the Bethlehem Shipbuilding Corporation, Ltd., Bethlehem, Pa.

Vickers, Ltd., Barrow-in-Furness, has received a contract from the Australian Government for three cargo steamers of 22,500 tons each. The vessels will be 530 feet between perpendiculars, 68-foot beam and 43 feet 6 inches molded depth.

The White Fuel Oil & Engineering Company, 601 Washington street, New York, has received a contract to convert four steamers into oil burners, including the *Empress Naviera, DeCuba* of 8,000 tons, the *Habana,* and the *Julia Alondes* of 5,000 tons, as well as other contracts on large vessels about which details are not yet available.

Yarrows, Ltd., Esquimault, B. C., has received an order for a 90-foot steel ferryboat which will be operated across the river at Mission, B. C. This new vessel of the shallow draft type will draw only three feet of water. Two Wisconsin gasoline engines, providing a total horsepower of from 160 to 180 will drive the four propellers.

NEW SHIPYARDS AND SHIPYARD EXTENSIONS

New ship yards and shipyards extensions

Steamship Company, San Francisco, Cal.—The Pacific Steamship Company contemplates expanding its capital by the issue of $25,000,000 (7 percent) preferred stock. The holding company, the Pacific Alaska Navigation Company, held a meeting November 29, to issue $1,500,000 to the stockholders in the corporation.

Ship Operating Company, Portland, Ore.—The Columbia Pacific Shipping Company has increased its capital from $100,000 to $3,000,000 and intends to operate in all channels of the shipping business. Several new ships are to be built in Portland yards for this company.

Launching Ways, Humboldt Bay, Cal.—The United States Coast Guard Service is advertising for bids for building a new set of launching ways for lifeboats at the coast guard station. The work will cost between $7,000 and $8,000.

Turbine Plant For Sale, Buffalo, N. Y.—The Victory turbine plant at Buffalo, N. Y., which was built by the Navy for the Bethlehem Shipbuilding Corporation, will be sold on November 17. The property cost originally more than $1,500,000.

Wooden Shipyard For Sale, Cornwells, Pa.—It is rumored that the United States Shipping Board Emergency Fleet Corporation may offer for sale the Traylor wooden shipyard on the Delaware river at Cornwells, Pa. The yard has built eight vessels. It covers an area of about eighty acres and has several large shops of steel and concrete construction.

Shipyard Extension, Baltimore, Md.—The Union Shipbuilding Company, Baltimore, Md., whose shipyard is at Fairfield, has arranged for additional facilities that will involve an investment of $4,000,000. Two permanent concrete shipways will be added to those already built, and also a two-story office building and a one-story plant structure.

Railway Drydock, Baltimore, Md.—The Union Shipbuilding Company, Baltimore, Md., will shortly commence construction of a railway drydock capable of drydocking vessels up to 4,000 tons displacement. The dock will be constructed of timber, will measure 360 feet over the keel-blocks and will have a draft of 20 feet over the blocks. The Crandall Engineering Company, dry dock engineers, East Boston, Mass., are the designers of the dock and will superintend the construction.

Two Railway Drydocks, Burin, Newfoundland.—The Western Marine Railways, Ltd., has contracted for the building of two railway drydocks of timber construction at Burin, Newfoundland. The larger of these drydocks will measure 170 feet over the keel-blocks and will be capable of handling vessels up to 1,000 tons displacement; the smaller will be capable of handling two vessels up to a displacement of 300 tons each. The Crandall Engineering Company, dry dock engineers, East Boston, Mass., will design and construct these docks.

Dry Dock and Ship Repair Corporation, Philadelphia, Pa.—The Dry Dock and Ship Repair Corporation of Philadelphia, capitalized at $5,005,000, has been organized at Wilmington, Del., to do a general ship repair, dry dock and shipbuilding business.

Navigation Company, Boston, Mass.—The Franco-Boston Navigation Company of Boston, was recently incorporated under the laws of Massachusetts. The charter of this company authorizes it to buy, own, build and operate vessels of all types. The directors of the company are Julia W. Troy, president, Anatole Farvacque, George L. Dillaway and Nina C. Tugman, all of Boston.

Dry Dock and Repair Corporation, Brooklyn, N. Y.—The Brooklyn Dry Dock and Repair Corporation, Brooklyn, N. Y., has recently been incorporated to manufacture engines, motors and accessories.

Shipyard Reorganization, Newark, N. J.—Arrangements have been made, although the actual contracts have not been signed, for the Submarine Boat Corporation, to acquire the Newark shipbuilding yards from the United States Shipping Board. All equipment and material for the last thirty-two 5,350 deadweight ton fabricated steel freighters recently cancelled by the United States Shipping Board, will be taken over by the Submarine Boat Corporation in the deal.

Shipyard Reorganization, Alexandria Bay, N. Y.—The shipyard of Young & Butnam at Alexandria Bay, N. Y., has been purchased by Hutchinson Brothers, for repair work and new construction.

Shipbuilding Plant Completed, Mobile, Ala.—The Tennessee Coal & Iron Company has announced the completion of construction at the Chickasaw Shipbuilding plant in Mobile. The Chickasaw Company has four 9,600-ton steel hulls on the way and ten others are to be built.

Marine Railway, Solomons, Md.—A large marine railway is being built at the shipyard of M. M. Davis & Son, Inc., Solomons, Md.

Machine Shop, Wilmington, Del.—The Delaware Marine & Motor Company, Commerce street, Wilmington, Del., is planning for the erection of a new one-story machine shop.

Shipbuilding Company, Dover, Del.—The United States Diesel & Shipbuilding Corporation, Dover, Del., has recently been incorporated with a capital of $1,000,000.

Shipbuilding Company, Newcastle-on-Tyne, England.—The Newcastle Shipbuilding Company, Newcastle-on-Tyne, England, has been incorporated as a private shipbuilding company, with a capital of £100,000 ($418,000), to take over the business of the Huntley Shipbuilding and Repairing Company, Hebburn, Durham. The members of the company include H. H. Doeg, marine engine builder, G. Armstrong, shipbuilder. The first directors of the company are J. Cross and H. H. Doeg.

Shipbuilding Company, Thames, England.—A new shipyard has been organized to be known as the Medway Shipbuilding Corporation, Ltd., with a capital of £100,000, to be located on the Thames, England, opposite the Chatham dock yard. The company plans to build nine shipways, which will accommodate vessels of 10,000 tons.

Shipbuilding Companies, Peru, S. A.—The State Department, Washington, D. C., learns that three large shipbuilding plants are likely to be established in the near future in Peru, one American, one English and one Italian.

Shipbuilding Plant, Kewanee, Wis.—The Wisconsin Shipbuilding & Navigation Corporation, 216 West Water street, Milwaukee, Wis., has begun the construction of a working plant at its yard, Kewanee, Wis. The work involves about $165,000. Later the fabricating shop will double this amount, but at present this work will be done in Milwaukee.

Shipbuilding and Repair Company, New Baltimore, N. Y.—The New Baltimore Shipbuilding & Repair Company, New Baltimore, N. Y., has been incorporated with a capital stock of $45,000, to build and repair ships. W. J. Wade, W. W. Stebbins and R. B. Drew, 597 Henry street, Brooklyn, N. Y., are the incorporators.

Shipbuilding and Repair Plant, Elizabeth City, N. C.—The Elizabeth City Iron Works & Supply Company, Elizabeth City, N. C., has purchased 670 feet of river front formerly occupied by the Fuel Supply Company upon which will be located a shipbuilding and repair plant to cost not less than $100,000. This plant will be in a position to handle repairs on the largest vessels entering this port.

Ship Repair Plant, New Orleans, La.—The Jahncke Dry Dock & Ship Repair Company, New Orleans, La., has completed its ship repair plant on the Mississippi river. About $3,000,000 has been expended for land, buildings, machinery, ship ways, etc. An eleven-pontoon drydock, operated in two sections

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of four and seven pontoons each can handle 4,000 and 7,000-ton vessels. When combined the drydock, which is 520 feet long, will accommodate 11,000-ton vessels. The fitting out basin is 1,600 feet long. The machine and plate shop, 320 feet by 70 feet, which is fitted with fifteen-ton cranes, and the two-story executive building furnish facilities for the adequate handling of all work.

Ship Repair Plant, Philadelphia, Pa.—The Dry Docks & Ship Repair Corporation of Philadelphia has recently been incorporated with a capital of $5,000,000.

Ship Repair Plant, Port Said.—The firm of Dowrie & Company, Port Said, has been made an Egyptian company, in which Sir John R. Ellerman, Bart., Henry Edward Barker, George Arthur Dowrie, Alfred Frederick Tunstall, Patrick Macpherson, Robert M. C. Moss, and Allan Stephenson, are the holders. The company will engage in repair and general engineering work at Port Said. All kinds of machinery and engineering material will have to be imported for this work. A. F. Tunstall and G. A. Dowrie will be actually in charge of the work.

Ship Repair Plant, Staten Island, N. Y.—Work has been begun on the 11-acre ship repair plant of Fraser, Brace & Company, 1328 Broadway, New York, located at Clifton, Staten Island. The facilities will include one 10,000-ton drydock, about 1,800 linear feet of pier space, 40 feet wide, one plate and angle shop, a blacksmith and pipe shop, and a carpenter shop, with tin and pattern shops, located in the second story.

Shipyard, Clyde, Scotland.—Hugh M. MacMillan, until recently shipyard director at Fairfield, and Donald Bremner, principal of the Port Glasgow firm of Messrs. Dunlop, Bremner & Company, are negotiating for the purchase of 650 feet of water frontage on the Clyde between the shipyard of Messrs. Yarrow and Coventry Ordnance Works. It is proposed to build five shipways on this site to accommodate vessels of from 10,000 to 12,000 tons' deadweight. Mr. Bremner will retain his position as managing director of the River Clyde Shipbuilding Works, Whiteinch. The new concern will be known as the Blythswood Shipbuilding Company.

Shipyard Combine, Quay-on-Tyne, England.—The Northumberland Shipbuilding Company, Ltd., Quay-on-Tyne, and the Fairfield Shipbuilding & Engineering Company, Ltd., Govan, are being consolidated. The former company, which operates seven berths capable of handling vessels up to 600 feet, has also obtained a controlling interest in Messrs. William Doxford & Sons, Ltd., Sunderland. The Govan company has eight shipbuilding berths.

Shipyard Control Changed, Seattle, Wash.—John H. Price, head of the J. H. Price Construction Company, Seattle, Wash., has recommenced work on two vessels standing in the yards of the Anderson Shipbuilding Company recently taken over by John L. McLean. The vessels, originally designed as steamships by Norwegian interests, will now be converted into full power auxiliary schooners.

Shipyard Discontinued, Portland, Ore.—The Albina Engine & Machine Works, Portland, Ore., according to a report, has been taken over by the Albina Engine & Machine Works Sales Company, a newly formed concern which was organized for the disposal of the stock and machinery on hand at the close of the shipbuilding programme. The consideration for the sale of the plant was given at about $220,000.

Shipyard Extensions, Perth Amboy, N. J.—The Perth Amboy Dry Dock Company, Perth Amboy, N. J., plans to build a boiler shop, a forge shop, a plate shop and a blacksmith shop on newly acquired property at the foot of Washington street, Perth Amboy. New crane runways will be constructed at both the present and the new plant to perfect the transportation facilities. Construction is now under way on a 10,000-ton sectional drydock, which will be self-docking and electrically operated. Two sections of this drydock will probably be launched before the first of next month, and the remainder as soon as possible, having in view the hauling of the first ship early in 1920, by which time the new facilities will be ready. The company now has a frontage on Staten Island of over 1,200 feet with railroad connections.

Shipyard Merger, England.—The Clyde Shipbuilding and Engineering Company, Ferguson Brothers and Murdock & Murray, three shipyards on the Clyde, will be brought under the same management by the merging of the Amalgamated Industries, Ltd., and the interests of John Slater, Ltd., London. During 1918 these yards produced 95,000 tons, exclusive of warship construction. In 1913, the yards produced 30,000 tons.

Shipyards, Ardrossan, England.—The Ardrossan Dry Dock & Shipbuilding Company, Ardrossan, England, is completing five shipways in its new south yard. Keels for vessels of 7,000 and 4,000 tons have recently been laid.

New Steamship Repair Company, Baltimore, Md.—The British American Steamship Repair Company, 51 South Gay street, Balmore, Md., has been incorporated to manufacture and repair engines and boilers. G. Alfred Peters, Jr., William M. Saunders and M. S. Chalmers, are the incorporators.

The Virginia Shipbuilding Company, Alexandria, Va., a subsidiary of the United States Steamship Company, 50 Broad street, New York, has repurchased ten vessels of 9,400 deadweight tons each from the Shipping Board at $225 per ton.

GOVERNMENT SALES

Tugs and Passenger Ship, Philadelphia, Pa.—In addition to the wooden hulls awaiting buyers at Hog Island, there are three tug boats and a passenger steamer to be sold by the Government, none of them having been built at Hog Island. The steamer is the *Cape May*, formerly the *Republic*. Some years ago the *Republic* was a famous excursion boat making daily trips between Philadelphia and Cape May.

Freighters, New York, N. Y.—The Luckenbach Steamship Company is negotiating with the Shipping Board for the purchase of four of its vessels which were requisitioned by the board. The four are 10,000-ton freighters built by the Bethlehem Shipbuilding Corporation at its Fore River plant, Quincy, Mass. The Shipping Board is asking $800,000 for each vessel in advance of the price the builders contracted for.

Boilers, Engines and Auxiliary Equipment, Piping Valves, Electric Supplies, Steel Plates, Shapes, Bars, etc.—The Emergency Fleet Corporation has available through cancellation of its war program a large quantity of surplus materials comprising boilers, engines and auxiliary equipment, piping valves, electrical supplies, steel plates, shapes, bars, etc., plumbing material, yard and shop handling devices, shop and wood-working machinery and tools, railroad equipment and a large lot of miscellaneous supplies. The prices for this material are considerably below the present market in most cases. Address inquiries to the home office of the Supply and Sales Division, 140 North Broad street, Philadelphia, or to the District Office, located at 139 Centre street, New York.

Steel Plates, Shapes and Bars, Philadelphia, Pa.—The Emergency Fleet Corporation, 140 North Broad street, Philadelphia, Pa., announces that it will offer for sale through its district offices about 200,000 tons of surplus steel in the form of plates, shapes and bars. Much of this material is fabricated and probably cannot be disposed of except as scrap. Sales will be made by means of competitive bids.

Yachts, Destroyers, Scows, Lighters, Barges and Motor Boats, Washington, D. C.—The Navy Department is advertising for sale a large number of vessels, including yachts, destroyers, scows, lighters, barges and motor boats. During the war the Navy built more than 455 submarine chasers, each 110 feet long, fitted with three standard gasolene engines of 220 horsepower each. These boats have been appraised at very low values in comparison with their original cost of from $75,000 to $80,000 each. According to Secretary Daniels, the terms of the sale are lenient. On vessels taken over during the war, a 10 percent deposit is required with the bid.

Wooden Ships, Washington, D. C.—The Emergency Fleet Corporation has placed on sale nearly 200 wooden ships of 3,500 tons deadweight, mostly of the Ferris type, at a fixed price of $75,000 each. The ships are to be sold at the Shattuck yard, Portsmouth, N. H.; Wilson's Point, South Norwalk, Conn.; Maryland Shipbuilding Company, Baltimore, Md.; Hog Island, Philadelphia, Pa.; Beaumont, Texas; Alameda, Cal.; Columbia Slough, Portland, Ore.; Lake Union, Seattle, Wash.

Battery Trucks, Tractors, a Battery Charging Plant and a Battery Crane Truck, Portland, Ore.—The Commission of Public Docks, Portland, Ore., has recently awarded a contract for furnishing two battery trucks, two battery tractors and a one-ton battery crane truck to the Automatic Transportation Company. The Commission has also recently awarded a contract for an electric battery charging plant to the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

HARBOR IMPROVEMENTS

Channel Improvement, James River, Va.—The Atlantic Deeper Waterways Association recently passed a resolution asking the Federal Government to make a new survey of the Lower James River with the view of deepening the channel from City Point to Newport News. The proposal includes dredging the channel to a depth of 25 feet.

Channel Improvements, Astoria, Ore.—As a result of the recommendations to be made by Secretary Daniels for the establishment of a naval base in the Columbia at a cost of $7,000,000, the improvement of the Columbia and Willamette river channels is urged, so that large war vessels may be accommodated. The Tongue Point site at Astoria is suggested, as it is strategically suited for a base.

Ship Canals, New Jersey.—The proposal to build a ship canal across New Jersey, to connect the existing inland waterway system, extending south to Florida, with the coast, has been submitted to the Rivers and Harbors Committee of the House by the New York and New Jersey Port and Harbor Development Commission. The state of New Jersey has appropriated $1,000,000 to acquire the right of way for this canal, which will run from Bordentown on the Delaware to Morgan on Raritan Bay.

Jamaica Bay Terminals, Long Island, N. Y.—The Sinking Fund Commission of New York City adopted a resolution recommending that the Board of Estimate authorize the issue of $7,500,000 corporate stock for the construction of six 1,000-foot piers. These piers will be built on condition that Congress authorize the construction and maintenance of a 30-foot entrance channel 1,500 feet wide, extending through Rockaway Inlet to Jamaica Bay, and a 30-foot interior channel, 1,000 feet wide, extending from the entrance channel to Mill Basin, and that the necessary dredging appropriations for this work be contributed by the Government.

Harbor Developments, Great Lakes District.—The United States Government is preparing to expend $5,000,000 on the following channel and harbor improvements for the benefit of the Great Lakes commerce: The deepening and widening of Livingstone Channel will be commenced soon. The proposed width is 450 feet. It has been estimated that $3,500,000 will be necessary to complete this work; the deepening and the widening of the Grosse Point Channel, to cost about $250,000 and the River Rouge improvement will involve the expenditure of $500,000. The east dyke at

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St. Claire Flats is to be repaired at an expense of approximately $40,000 for the protection of Lake shipping; the Harbor of Refuge at Harbor Beach, will be dredged at an approximate cost of $150,000 to afford shelter to vessels from storms, and a breakwater is to be constructed at Alpens, at an estimated cost of $75,000.

Wharves, Cape Fear River, Fayetteville, N. C.—The city of Fayetteville, N. C., has voted the issuing of $75,000 in bonds for the construction of wharves on the Cape Fear river. For further information address the Mayor.

Terminal Developments, Seattle, Wash.—The Seattle Harbor Commission on recommendation of George F. Nicholson, engineer, has authorized asking for bids for the construction of the first half of the East transit shed at the New Smith Cover pier "B" terminal, which is to include the passenger accommodations to be erected. Bids for this work will be opened November 26 and plans and specifications may be had on application to the engineer in Seattle. The Commission has also decided to ask for bids for the erection of four additional oil storage tanks at Smith Cover, pier "A," each to be of steel or concrete and of 50,000 gallons capacity. The date for the opening of these bids has not been set.

Harbor Developments, Kalamata, Greece.—A project is on foot for the development of the port of Kalamata, Greece, which offers a possible opportunity for an American firm. The improvements contemplated include the deepening of the harbor, the construction of waterworks, the dredging of the river, and a number of minor improvements. It is estimated that the cost of deepening the harbor would amount to approximately 1,000,000 drachmas ($193,000).

Coaling Machines, Norfolk, Va.—The Division of Operations of the United States Shipping Board, Emergency Fleet Corporation, invites bids for the sale of coaling machines and spare parts, among them being five new DeMayo 40-foot machines manufactured by the American Car & Foundry Company, Berwick, Pa. These machines and spare parts are now in storage at the Engineer's Depot, Lambert's Point, Norfolk, Va. Permission to inspect may be had upon application to Mr. L. L. Leger, Purchasing Agent, Division of Operations, Flat Iron Building, Norfolk, Va.

Wharves and Warehouses, Beaumont, Tex.—The city of Beaumont, Tex., because of traffic having diverted to southern ports by the Shipping Board, intends to spend $500,000 immediately in building adequate wharves and warehouse to handle the cotton, lumber and oil which are shipped from the port.

Ship Channel, Miami, Fla.—The city of Miami, Fla., has voted on $40,000 bonds for the completion of a ship channel across Biscayne Bay. J. T. Blackmon is the acting mayor.

Inner Harbor Navigation Canal, New Orleans, La.—The Dock Board, New Orleans, La., is planning to issue $7,500,000 in bonds for the completion of the inner harbor navigation canal. J. B. O'Reilly is the engineer.

Reinforced Concrete Pier with Bridge and Ferry Slip, Bay Shore and Rock Hall, Md.—The Baltimore & Eastern Shore Ferry Line, S. A. Tubman, vice-president and manager, Room 613, Lexington building, Baltimore, Md., plans to construct a 1,000-foot reinforced concrete pier with bridge and ferry slip at Bay Shore, and at Rock Hall, Md. M. D. Swartz, Madison avenue and Preston street, Baltimore is the engineer, and the Raymond Concrete Pile Company, Baltimore, is the contractor.

Dredging and Rock Removal, East River, N. Y.—The New Jersey Shipbuilding and Dredging Company, Bayonne, N. J., has been awarded a contract for dredging and rock removal in the East River, New York, at a cost of $668,122.

Harbor Development, Wilmington, Del.—The City Council of Wilmington, Del., has authorized a bond issue of $2,500,000 for the purpose of developing the port. The work will include the building of a bulkhead wharf 1,200 feet long, a three-story warehouse 600 feet by 200 feet, and the dredging of the ship channel to a depth of 35 feet, so that ocean-going vessels will be able to dock. Cranes and cargo-handling machinery of the latest types will be installed. An additional appropriation of $150,000 has been made for the construction of sheds and bulkheads and river craft at the railroad terminals.

Port Improvements, Cincinnati, O.—About $175,000 is to be spent in improving the wharves and docks of Cincinnati.

Harbor Improvements, Portland, Ore.—The Port of Portland Harbor Commissioners, Portland, Ore., plan to purchase Swan Island. It is expected that this location will be dredged out and serve as a boat basin, or the island itself may be equipped with docking facilities.

Navigation Canal, New Orleans, La.—The Dock Board, New Orleans, La., is planning to issue $7,500,000 in bonds for the completion of the inner harbor navigation canal. J. B. O'Reilly is the city engineer.

Pier, Baltimore, Md.—B. Powell Harrison, harbor engineer, Baltimore, Md., recommends the building of a large, modern pier at McComas street, at an estimated cost of $400,000. The Board of Estimates is considering the temporary diversion of civic center funds to this use.

Pier, Charleston, S. C.—The Standard Oil Company plans to construct a 1,200-foot dock at Charleston, S. C., to accommodate two vessels. G. R. Lukesh is in charge of the work.

Pier, West Waterways, Seattle, Wash.—The Frank Waterhouse Company, Seattle, Wash., has applied to the Seattle Port Commission for a permit to build a pier at the northwest section of the West Waterways. According to the plans submitted to the commission, the Waterhouse Company seeks to extend its property 155 feet on to the Railroad avenue waterway extension. If permission is granted for this construction, it is understood that the expenditure for the pier will be about $2,000,000.

Sales Building, London, England.—Irving T. Bush has made arrangements for leasing the Strand Aldwych site in London to the Bush Terminal Company for ninety-nine years, at an annual rental of £55,000. The building to be erected on this site will be eight stories high.

Steamship Office Building, New York.—A. H. Bull & Company, 17 Battery Place, New York, has purchased a five-story building, 34-40 West street, New York, which will be used for future developments of the company's executive offices.

Ship Channel, Biscayne Bay, Fla.—The city of Miami, Fla., has voted on $40,000 bonds for the completion of a ship channel across Biscayne Bay. J. T. Blackmon is the acting mayor.

Steamship Terminals, Hunt's Point, New York.—Robert Dollar, president of the Dollar Steamship Company, San Francisco, Calif., has purchased fourteen acres of property providing 700-feet of waterfront at Hunt's Point, Bronx, New York, which will be developed for steamship terminals to be used when the company extends its service to New York. The sum of $356,250 was paid for the tract. H. P. Schuck, general manager of the Dollar Steamship Company in New York, has stated that $1,000,000 would be spent in the construction of harbor facilities at this point.

Terminal Project, Jamaica Bay, L. I.—A $100,000,000 syndicate, in which Alton H. Greeley, one of the principal warehouse owners in Cleveland, is interested, plans to construct piers and warehouses at Jamaica Bay, L. I. The beginning of construction work on the project rests upon Federal action in providing a 30-foot channel.

Terminal Reconstruction, Memphis, Tenn.—The City of Memphis, Tenn., plans to spend $178,000 in remodeling its existing terminals. Freight will be handled from barge to warehouse or cars by means of tractor or trailer trucks. These trailer trucks will be elevated to the bank by means of a tractor conveyor incline. On the upper level trailers will be moved by electric tractors. As the work has just been authorized, working plans are not now available. The construction does not include warehouses or piers. W. F. Schulz is consulting engineer.

Terminals, Cordova, Ala.—Manager Henry T. DeBardeleben, of the Warrior River Barge Canal Commission, has announced that contracts will soon be let for the construction of terminals at Cordova, Ala., to cost about $30,000.

Turning Basin, Birmingham, Ala.—Charles F. Wood, engineer, Birmingham, Ala., recommends the building of a turning basin in connection with the river barge terminals at this port.

Wharf, Pascagoula, Miss.—Bids were received on November 10, by C. H. Lewis, mayor, Pascagoula, Miss., for the construction of a 1,000-foot wharf including the laying of 3,000 feet of rails. About $75,000 will be spent on the work. W. H. Wallis is the engineer.

Wharves, Cape Fear River, N. C.—The city of Fayetteville, N. C., has voted to issue $75,000 in bonds for the construction of wharves on the Cape Fear river. For further information address the Mayor.

SHIPPING DEVELOPMENTS

New Steamship Company, New York.—The Green Star Steamship Corporation, headed by Joseph Mercadante, formerly president of the Nafra Company, and Robert McGregor, formerly general manager of the Federal Shipbuilding Corporation, has been incorporated with a capital of $10,000,000 to develop world trade. Ten steel Shipping Board vessels will be placed in this service.

New Steamship Companies, New York.—F. & J. Auditore, stevedores, 44 Sackett street, Brooklyn, and Charles L. Apfel, attorney-at-law, 35 Nassau street, New York, have organized the Susquehanna, Redondo, Sacramento and Lydia Steamship Companies to operate vessels in world trade.

Shipping Combine, Seattle, Wash.—The Universal Shipping & Trading Company, Seattle, Wash., will become amalgamated with the shipping firm of Frank Waterhouse & Company, according to a statement made by P. H. Hammer, president and general manager of the former company. The new organization will enter the Eastern shipping field at once.

The Green Star Steamship Corporation, 120 Broadway, New York, has purchased four 8,800-ton deadweight cargo carriers which are being built by the Northwest Steel Company, Portland, Ore.

Large Oil Depot, Belfast, Ireland.—Preparations have been made for the establishment of a large oil depot at Belfast, Ireland. Wharfage will be provided for oil tankers ranging from 10,000 to 20,000 tons.

New British Ship Venture in Central Europe.—A report from reliable sources states that British capital has purchased a controlling interest in the Danube Steamship Company, which operates and practically controls inland water navigation in Central Europe. The company is capitalized at 54,400,000 crowns, including a valuable coal mine at Funfkirchen, Hungary.

New Shipping Combine, Antwerp, Belgium.—The American Chamber of Commerce in London states that a new Franco-Belgian shipping combine has been formed in Antwerp with a capital of 25,000,000 francs. The steamers will sail under the Belgian flag to Canada, the United States and points on the Pacific coast from Antwerp.

New Shipping Company, Wilmington, Del.—The United Shipping Company, Inc., care of Delaware Registration Trust Company, 900 Market street, Wilmington, Del., has recently been incorporated.

New Shipping Company, Jacksonville, Fla.—The Jacksonville Shipping Corporation, Jacksonville, Fla., has recently been incorporated.

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